DOCUMENT RESUME

ED 324 223 SE 051 607

TITLE	The Second Voyage of the Mimi.
INSTITUTION	Bank Street Coll. of Education, New York, N.Y.
SPONS AGENCY	Department of Education, Washington, DC.; National Science Foundation, Washington, D.C.
REPORT NO	ISBN-1-55636-761-9
PUB DATE	89
NOTE	163p.; Contains some colored pages and pictures which may not reproduce well.
AVAILABLE FROM	Sunburst Communications, 39 Washington Avenue, Pleasantville, NY 10570 ($9.90).
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052) -- Books (010)
EDRS PRICE	MF01/PC07 Plus Postage.
DESCRIPTORS	Ancient History; Archaeology; *Cultural Awareness; *Cultural Influences; Entomology; *Interdisciplinary Approach; Map Skills; Marine Biology; Meteorology; Physics; Science Activities; *Science and Society; Science Education; Scientific Literacy; Scientific Methodology; Scientific Principles; Scientific Research; Secondary Education; *Secondary School Science; Social Studies; Technology
IDENTIFIERS	*Voyage of the Mimi

ABSTRACT

This book includes 12 units that have been adapted from the television series "Voyage of the Mimi." Each unit includes the episode, an activity, and an expedition. The episodes introduce and accompany each episode of the television series. The activity is an extension of that episode which can be done in the classroom. Mapping skills, foreign languages, cultural awareness, marine biology, scuba diving and pressure changes, archaeology, secret messages using polar coordinates, insects, and writing journals are topics covered in activities. Expeditions relate aspects of the taping of the show or a person who worked for the company. A glossary of terms used in the series is included. (KR)

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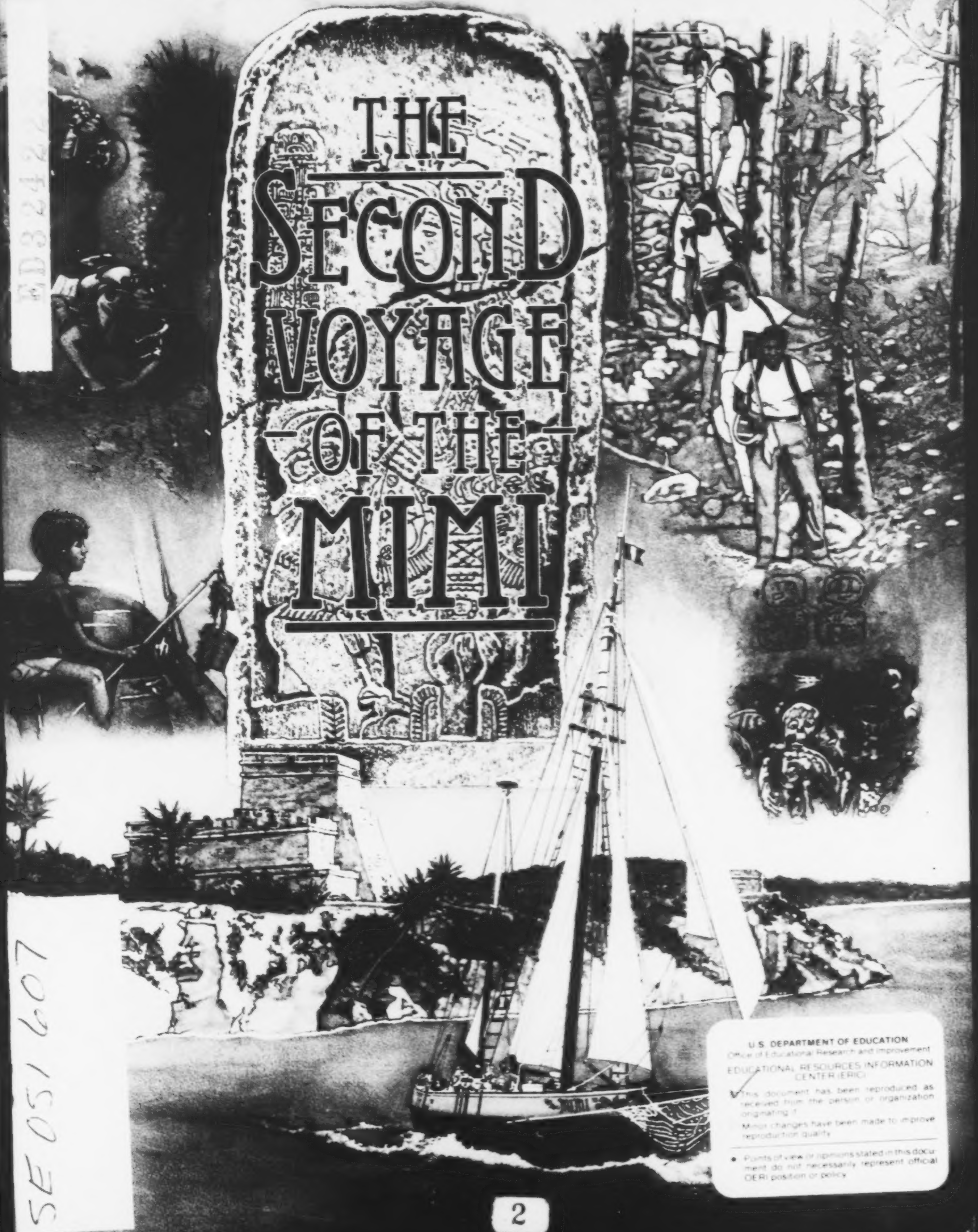

THE SECOND VOYAGE OF THE MIMI

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THE
SECOND
VOYAGE
OF THE
MIMI

THE BOOK

**THE BANK STREET COLLEGE
PROJECT IN SCIENCE AND MATHEMATICS**

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Executive Director

Based on the television series,
"The Second Voyage of the *Mimi*," written by
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The television series, "The Second Voyage of the *Mimi*," was produced with funding from U.S. Department of Education and National Science Foundation. Its content and the content of this book are solely the responsibility of Bank Street College. Copyright (c) 1989, Bank Street College of Education.

Sunburst Communications
ISBN 1-55636-761-9

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A CHARTER TO THE PAST

M*imi* motored slowly beneath the blue sky near Cozumel Island off the coast of Mexico. Captain Granville was at the wheel. His grandson C.T. was enjoying the peaceful afternoon. Three years ago C.T. had first sailed with his grandfather in the Gulf of Maine. Now Captain Granville had brought *Mimi* to warmer waters for the winter, and he was happy to have C.T. visit for several weeks.

It was growing late, and the tourists who had chartered *Mimi* were relaxing after a busy day of fishing. All except one, that is.

"I got a bite!" Sam's exclamation roused the others. "Hey, hey, hey!" Sam continued excitedly. "I got something here!"

"Better late than never," his friend Nelson joked.

"Better get the hook, C.T.," Captain Granville said to his first mate.

Sam, with zero luck fishing so far, was sure he had the biggest catch of the day. "Earn your keep, kid," he said to C.T. "This one's going to take more than one man." He struggled to bring his catch on board, watching the end of his line as he reeled it in, eager for the first glimpse of his prize fish.

When Sam's catch finally broke the surface, excitement instantly turned to dismay. Dangling from the end of his line in a tangle of seaweed was a clay pot!

"What is it?" Margaret asked, as C.T. removed the bait, the seaweed and the pot from the hook.

"It's a pot," Carol laughed.

"Give him a break, Carol," said [illegible] "It's a [illegible]."

The pot was about nine inches tall, a pear shape, and it was decorated with strange figures and oddly shaped [illegible] a jagged hole on one side near the [illegible] the decorations were faded, but otherwise it was in good condition.

"It's one of those Maya pots," Margaret said, looking more closely.

C.T. didn't know what a Maya was.

"They're the Indians who lived here before the Spanish **conquistadors** came," Carol told him.

Margaret added, "They built amazing cities, C.T., fifteen hundred years ago."

C.T. wondered if the pot was fifteen hundred years old, but Carol said it was probably a **replica** from a souvenir shop.

Just then Captain Granville announced that it was time to head back to port.

As first mate, C.T.'s job included supervising the raising of the sails. He called out orders to Mr. and Mrs. Borden and Mr. and Mrs. Jeffries. Soon, *Mimi* was gliding through the water under full sail. C.T. climbed up to the crosstrees. So high above the water with the wind in his face, able to see to the horizon in all directions, it almost felt like flying.

"Hey, C.T.!" his grandfather called from below. "Take a look off the port bow."

C.T. looked toward the shore. Atop the cliffs overlooking a lagoon was an imposing building made of grayish stones.

"Must be one of those Maya temples, right?" C.T. asked.

"It's a place called Tulúm," Captain Granville answered.

It wasn't long before *Mimi* was moored at the dock in Cozumel harbor. The tourists collected their gear and the fish they'd caught.

"Mr. Borden," C.T. called, "don't forget your potfish." He tossed the pot to Sam, who was still a little embarrassed about the only "fish" he'd caught that day.

"When do you go back to Ohio?" Margaret asked C.T.

He told her that he'd be staying with his grandfather until after Christmas, keeping up with his studies while he was out of school.

"Travel's the best education there is," Carol said.

"Hey, C.T.," Mr. Borden called, "here you go." He tossed the souvenir pot to C.T., who caught it just before it fell into the water. "You can keep your bait in it."

It would be a neat place for bait and a good souvenir of his trip, C.T. thought. "Thanks!" he called out.

With the tourists gone, Captain Granville and C.T. had chores to do. They were mopping the decks, when from down the dock they heard the sound of an argument.

"But it isn't fair!" a young woman with long blonde hair was saying.

"I'll decide what's fair," said the man she was with. "You decide whether you want a job or not. You're lucky I took you on."

The young woman walked away from the man and headed down the dock. As she approached *Mimi*, something caught her eye. "Excuse me," she said. "Is this your boat?"

"Yup," Captain Granville said, not looking up from his work.

C.T. did look up. The young woman was obviously very interested in *Mimi*. And C.T. noticed she had an artificial leg.

"Say," the young woman continued, "you wouldn't by any chance know a Harold Thornton, would you?"

The Captain was still not paying much attention. "Nope," he said.

"*Sticker* Thornton?"

That got his attention. The Captain stood up and leaned on his mop, a broad smile on his face. "Sticker Thornton! By golly, you bet I know Sticker Thornton. Been in more oceans and more cafes together than I'd care to... I haven't seen him for twenty years. Never forget him, though. He saved my life once."

"He tells it the other way around," the young woman said.

"So you know Sticker, huh?"

"He's my dad."

"Well, I'll be darned," said the Captain, putting down his mop at last. He reached out to shake hands and introduced himself. "Clement Granville."

"They call me Pepper," the young woman said, shaking hands.

Captain Granville introduced Pepper to C.T., then asked, "What made you stop here?"

Pepper told him she'd grown up hearing stories from her father about Granny Granville and his wife, Mimi. And she'd seen that *Mimi* was from Gloucester.

C.T. heard the unfamiliar nickname Pepper had used. “Granny?!” he said, looking wide-eyed at his grandfather, who gave him a stern glance that said, *Just pretend you didn't hear that!*

Captain Granville told Pepper that the boat was named after his wife, who had passed away twelve years ago.

“How long have you been crewing for your grandfather?” Pepper asked C.T.

“Well, five and a half days,” said C.T. “But I learned a couple of summers ago.”

They were interrupted by the man Pepper had been arguing with earlier. “It's nice to see you've got so much spare time, Miss Thornton.” He was a tall, unfriendly looking man who seemed to sneer as he talked.

Pepper introduced the Captain and C.T. to Harvey Westerman. Westerman wasn't very interested in making friends. “I'll see you in the morning,” he said to Pepper, walking away. “And you see to the tanks. Twenty-five hundred pounds.”

C.T. was relieved this guy was gone. He really seemed like a bully. “Is that your boss?”

Pepper explained that Westerman owned a string of dive boats to take tourists **scuba** diving on the coral reefs. She worked for him as scuba instructor and leader of the dives. Their argument had been about how much air to put in tourists' tanks. “Westerman keeps trying to get me to put less air in the tanks so people can't stay down so long. I ignore him.”

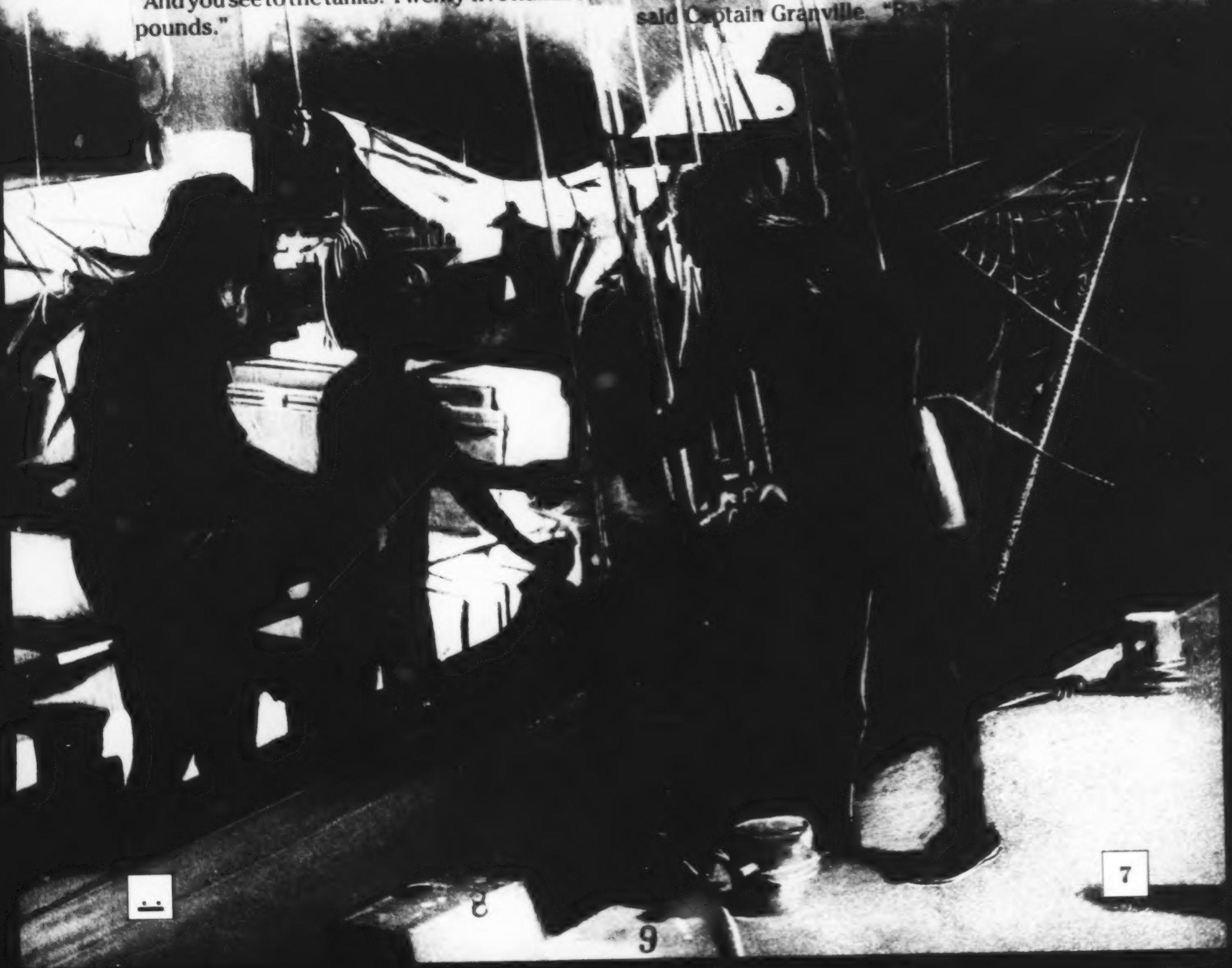
C.T. was curious. “What happened to your leg?” he asked.

Captain Granville was a little embarrassed, but Pepper reassured him that she didn't mind the question. She said she'd had cancer about five years ago. “They gave me a choice: me or my leg.”

“And you can swim and all?” C.T. asked.

“Swimming's the easy part,” said Pepper, smiling. She looked at her watch. “I should get going.”

“We'll walk down the dock with you,” said Captain Granville. “[illegible]



As the three headed down the dock, the Captain told Pepper that he was supposed to meet two people about chartering *Mimi*. He thought Pepper might know them.

"Terry Gibbs and Victor Cobos," said Pepper, looking at the names the Captain had written on a piece of paper. "I've taken them diving a lot. Good people. Scientists."

She said they were **archaeologists** studying the Maya ruins. Victor was Mexican and Terry was from the United States. She added that Terry was interested in Maya pottery.

That gave C.T. an idea. He dashed back to *Mimi* and grabbed the souvenir pot. Maybe these archaeologists could tell him something about it.

Captain Granville and C.T. met the two archaeologists and went into a restaurant to talk business. When they entered, Harvey Westerman was there with two people who were looking at something wrapped in paper—a clay figure of some sort. "Put it away! Cover it up!" Harvey said urgently, thrusting a wad of money into his pocket. The arrival of Terry and Victor had made him very nervous, and he left the restaurant in a hurry.

The Captain, C.T., Terry and Victor ordered their drinks and got down to business.

"Here's what we have in mind," Terry said. She described how she and Victor often were intersted in the same questions about the ancient Maya, but usually disagreed about the answers. They did agree, however, that the Maya used the ocean for trading, using huge dugout canoes. In the 1500s, Columbus had seen a 70-foot Maya canoe off the coast of Quintana Roo. The Maya traded on the sea all during the "Classic Period" of their civilization, from 200 to 900 A.D.

"What did they haul?" Captain Granville wanted to know.

"Many things," Victor answered. "Corn, cloth..."

"How about clay pots?" C.T. asked.

"Sure, those too," said Victor. "Pots—that's Terry's specialty."

Terry went on to explain that she and Victor had gotten some money from the National Institute of Anthropology and History—called INAH—to study Maya trade practices. INAH was in charge of all the archaeology in Mexico. She and Victor wanted to investigate some of the ancient Maya ports, such as Tulúm, underwater. That's where *Mimi* came in.

"*Under* the water?" asked the Captain.

Terry nodded. "Our **hypothesis** is that there just might be some Maya cargo down there. It could tell us more about what was traded, where, how, and maybe even why. We're always building theories, painting new pictures of the past."

Captain Granville wondered why Terry and Victor wanted to hire him, since he had only been there for two months, and didn't know the waters in the area that well. "Why not someone like that Westerman fellow?"

Victor obviously felt a little uncomfortable. He couldn't quite bring himself to say what he was thinking.

But Terry could. "Oh, Victor," she said. "He's a first-class sleaze," she said, referring to Westerman. "Your own department at INAH has suspected him for years of **looting**—stealing Maya artifacts and selling them, which is illegal."

It sounded like a great adventure to C.T. "So we'll do it, Grandpa?"

The only question was whether Captain Granville could handle the scuba diving this job would involve. The Captain wasn't sure, but he did have an idea. "Maybe there is someone who can help us with that," he said.

"Then it's a deal?" Terry asked.

"It's a deal."

The four of them raised their glasses to celebrate their new partnership.

In all the excitement, C.T. had nearly forgotten. "Maybe I already found something for you guys," he said, pulling the "potfish" out of his pack.

"Where did you get this?" Victor asked.

C.T. told them how one of their charter customers had caught it fishing.

"Well, that's pretty good fishing!" Terry said, examining the pot. "But I'm afraid this fish isn't very old."

"How do you know it isn't old?" C.T. asked.

"Well," Terry said, "if it had been down there for even a few months, it would have something growing on it, like algae or even coral. You can imagine what it would be like after a thousand years or so."

"You mean it's a fake?" C.T. asked, disappointed. "How could it get to the bottom of the ocean?"

Victor thought maybe tourists had thrown it or dropped it there.

C.T. had liked the idea that the pot might have been made by the ancient people called the Maya. "I wonder what they were really like," he said aloud, thinking of the temple of Tulúm that he had seen from *Mimi* today and trying to imagine the people who had built it.

Terry could see that C.T. was intrigued. "Captain Granville," she said, "Victor and I have to go back to Palenque to pick up our gear." She went on to explain that even though the Captain hardly knew her, she'd love to take C.T. with them. It would be a great chance for him to see some of the ruins up close. "I have an 11-year-old who'd get along great with C.T.," she continued.

"Can I, Grandpa?" C.T. asked eagerly.

The Captain was a little uncertain, and Terry and Victor asked him to think about it and let them know.

C.T. and the Captain headed back to *Mimi*. C.T. was determined to convince his grandfather to let him go to Palenque. "I'll understand it if you don't want me to go with them," he said. After a pause, he added, "...even though it would be a real educational experience, like Mom promised the principal you'd give me."

Captain Granville smiled. This persuasion was beginning to take an interesting turn.

"Of course," C.T. continued, "if you don't, I might just have to let a few people know about that nickname of yours....Granny!"

C.T. tried to get away, but he wasn't fast enough. Pretending to be angry but with a smile on his face, Captain Granville grabbed his grandson. They laughed, as C.T. protested, "All right! I don't want to go!"

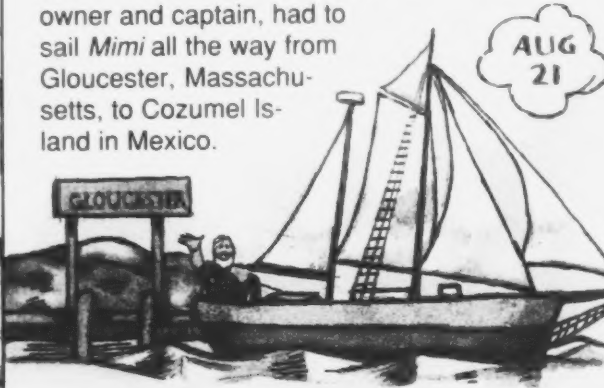
But, of course, they both knew he d

-ACTIVITY-

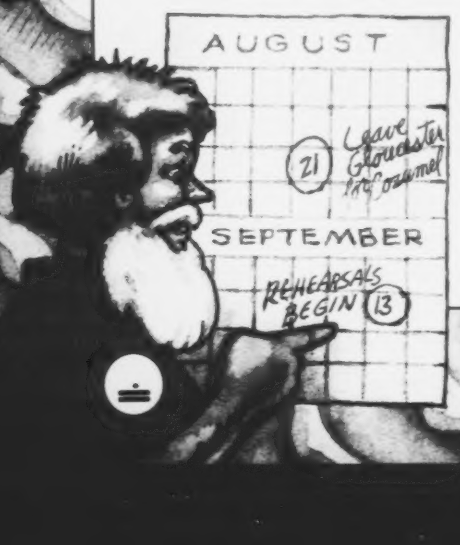
Where's Mimi?

SAVANNAH
BOAT REPAIR
AUG 30

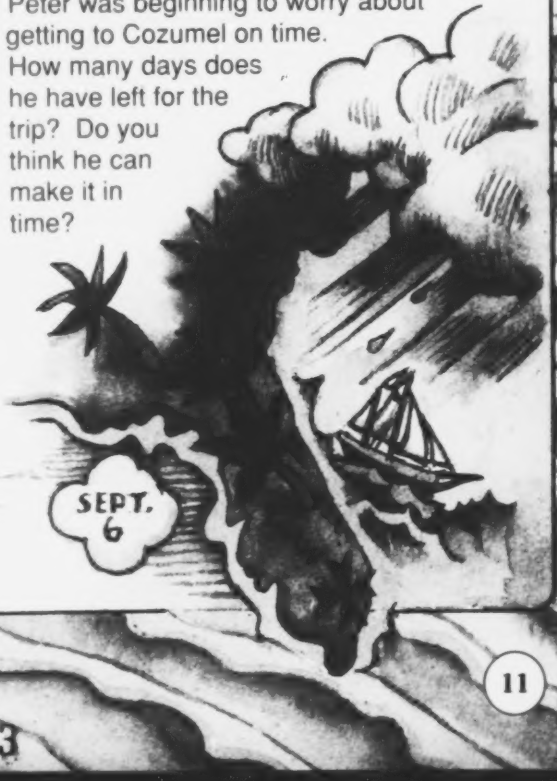
In the story of the first "Voyage of the *Mimi*," Captain Granville nearly died from **hypothermia** after falling overboard during a storm. In the story of "The Second Voyage of the *Mimi*," the sensible Captain decided to put *Mimi* up for charter in a place where the weather is sunny and warm--a place like Mexico. So, for the filming of "The Second Voyage of the *Mimi*," Peter Marston, who plays Captain Granville and is also *Mimi*'s real-life owner and captain, had to sail *Mimi* all the way from Gloucester, Massachusetts, to Cozumel Island in Mexico.



1. Use a map of North and Central America to decide on the best route for *Mimi* to take.
2. *Mimi* travels day and night. When the wind is favorable, she sails at 6 knots. (A knot is 1 nautical mile per hour.) When there's no wind and at night, she motors at the same speed. How far can she get in 24 hours under favorable conditions?
3. Peter had to get *Mimi* to Cozumel bySeptember 13th for the first rehearsals of "The Second Voyage." It's about 1800 nautical miles from Gloucester to Cozumel. *Mimi* left Gloucester on August 21st. If the weather remained good and they didn't have to stop for any reason, how long would the whole trip take?



4. Of course, the weather never stays good and things break down. On August 26th, after only six days, *Mimi*'s **sonar** acted up. Peter had to make port in Savannah, Georgia, and wait for a week until it was repaired. He set sail again on September 3rd. They had clear sailing for three more days. Then, on September 6th, there was a hurricane warning for the waters off southern Florida. Peter brought *Mimi* to harbor to be safe. They stayed three days in Miami until the hurricane passed. It was already September 8th! Peter was beginning to worry about getting to Cozumel on time. How many days does he have left for the trip? Do you think he can make it in time?



EXPEDITION

IF I CAN DO THIS . . .

Months after "The Second Voyage of the *Mimi*" was filmed in Mexico, Ben Affleck, the actor who plays C.T., took a trip to Jackson Hole, Wyoming. He went there to see Martha Hill compete in the National Disabled Ski Championships. Martha plays the role of Pepper in "The Second Voyage of the *Mimi*."

Jackson Hole has some of the toughest ski slopes in the world. For the past fifteen years, skiers with all kinds of disabilities have come here to compete. All are out to do their best. "I think it's because we don't like to think of ourselves as *un*able just because we are *dis*abled," Martha explained. "Sort of like our motto says, 'If I can do this, I can do anything.'"

There is even a downhill course here for blind skiers. Each blind skier has a sighted partner skiing ahead, yelling directions back to

Ben Affleck and Martha Hill.

HANDICAPPED
LEARN TO SKI
CLINICS
7 ELEVEN
EASTERN

Martha and her fellow competitors, Lana Jo Chapin and Diana Golden, talked with Ben about their experiences as athletes and as people with disabilities.

"turn" or "tuck." Some blind skiers don't even need directions. They just listen for the sound of their partner's skis.

The competition at Jackson Hole was really important to Martha. She had a chance to be named the best all around skier in her class and then go on to represent the United States at the World Championships in Sweden. She had already won two out of the three events, including the slalom, her favorite race. But still to come was the downhill race, and for Martha, that would be the toughest event.

After an afternoon practice session, Martha introduced Ben to some of her friends and fellow competitors, Lana Jo Chapin and Diana Golden.

"Do you compete with each other?" Ben asked.

"We sure do," Diana said. "Martha and I are both on one leg, and she skis on outriggers and I ski on poles, but we're in the same class. Lana is a below-the-knee **amputee** and she skis on two skis with poles. But we're all out to beat each other, no matter what the class."

Ben asked, "Does it bother you when people ask you about your amputations?"

Lana answered, "It depends on how it's asked and on the situation."

"I prefer people to ask rather than to sit back and just stare," said Martha.

Diana continued, "And all of us are usually just as curious about each other's disabilities as other people are. Did you have a disease? Did you have an accident? Even though Martha's handicap looks to be the same, she's gone through different things, so I want to know what it was like for her."

Later, in Martha's room, Ben and Martha had a chance to talk privately. "Could you hand me my leg?" Martha asked.

Ben was taken aback for a second, but he turned and reached for the artificial limb that Martha sometimes uses. He had never seen her put her **prosthesis** on before, and she showed him how it works.

Martha wrapped a long sock around her stump. Then she pulled the end of the sock though a small hole near the top of the prosthesis. As she stepped into the limb, she pulled the sock out through the hole. Then she closed the little hole with a valve, sealing out the air. No air can get in the socket, so the leg stays on without any kind of extra assistance.

Martha explained to Ben how her prosthesis works and showed him how she puts it on. The leg, which was molded to fit Martha's stump, has a valve to seal out air. Once the leg is on and the valve is closed, the leg stays on without any additional means of attachment.

To make the leg, the doctors took a cast of Martha's stump and formed the socket to fit exactly. The socket was made from soft plastic which contracts and expands when she moves her muscles. It fits better that way and helps maintain the suction so the leg doesn't slip off.

"Do you have a bone in your stump?" Ben asked, growing more interested and more comfortable as he and Martha talked.

"Yes, I do." Martha showed Ben her leg, which ends about mid-thigh. The stump has a neat-looking line along the bottom where doctors stitched together the skin. Martha pointed to where the bone ends, about two inches from the bottom of the stump.

"The doctors wrapped all my muscles around the bone so that I still had strength." Her artificial leg weighs seven pounds, so that short bone lifts up seven pounds every time Martha takes a step.

Martha finished putting on the leg and pointed to another prosthesis in the corner. "That's the leg I had when we filmed the '*Mimi.*' This one has a knee joint, and that one doesn't." Martha's new prosthesis was sculpted from soft foam to look just like her other leg.

The downhill race was the most challenging event for Martha. If she could do well enough, she would be the National Champion! Here she is on the steep downhill course.

"What did you think when you first found out you had cancer?" Ben asked. "Did you know you were going to have to lose your leg?"

"When they first told me I had cancer," Martha said, "they weren't sure what kind I had. But they were pretty sure they were going to have to amputate. I was treated at Mayo Clinic. I was their 28th case of my type of cancer. The 26th had died and the 27th wasn't doing very well."

Martha's treatment began the day after she was **diagnosed**. "Within three weeks, I knew there was no way they could save my leg. By the time they'd finished the **radiation** I was ready to get rid of it. I'd always been really active and I was just carrying a lot of dead weight. I had known for two months that they probably would amputate, and I think that made it a lot easier."

"Were you scared at all that you might die?" Ben asked.

"I knew it was pretty serious. At one point when I was filling out my hospital menu I was kind of laughing because I really didn't know whether I was going to be there the next day to eat it or not. But suddenly all my treatments started taking, and I knew I wasn't going to die. And I just started getting better and better and I've been fine ever since."

Ben asked Martha if she ever got pain from the wound.

"I get something called **phantom pains**. After they amputated, I still had all the nerves and all the nerve endings. So every now and then I can feel my toes. Right now I can feel my big toe and my second toe and my baby toe. They feel like they're asleep. You know that tingling sensation you get?" Sometimes she can even feel the **tumor** in her knee.

"No one really knows why I ever got cancer," Martha said, "and they don't know why I'm still here. But I'm just happy to be here. When it comes down to a life and a limb, there really isn't a comparison as far as I'm concerned."

The final and most dangerous part of the competition—the downhill race—took place the next day. Ben took a look at the steep course. "I sure wouldn't go down that!" he said.

Martha invited Ben to the awards dinner at the end of the competition.

As National Champion in her class, Martha now had to start training for the World Championship competition. For Ben, just skiing down one gentle slope without falling was challenge enough.

If Martha could do well in the downhill, she would have a chance to win the overall championship. But it wouldn't be easy. Skiers were reaching sixty miles an hour on the course, and many of them had fallen. Martha had fallen on both her practice runs.

Ben waited at the most dangerous part of the downhill course for Martha to ski by. "Go, Martha! Go!" he shouted as she raced by.

Martha seemed to fly down the steep, bumpy course. She finished without falling. And her time was good enough to win the title! Martha was the National Champion!

Later, when Martha went up to receive her medal, the announcer said, "And here's our own resident movie star, Martha Hill."

After the award ceremony Martha and Ben skied down a gentle slope together. As Ben struggled to keep his balance, Martha encouraged him. "You'll get it. You're doing great!"

DISABLED OR DIFFERENTLY-ABLED?

A handicap is something that makes it unusually difficult to accomplish your goals. In some ways everyone has handicaps. Physically disabled people are handicapped by things most of us don't even think about. For example, going to school can be unusually difficult.

Check out your school. Could a person in a wheelchair get into the building? The classrooms? The bathrooms? What about being able to write on the blackboard? Are there kids who might make fun of a handicapped person? Are there kids who would be friendly?

List some changes in the design of your school or classroom that might make it easier for a person in a wheelchair to go to school.

Think about other physical disabilities, such as blindness or deafness. What would make it easier for a deaf or blind person to go to school?

What are some things that make it difficult for you to achieve your goals? What are some ways people overcome their handicaps and develop special skills?

EPISODE

A TOMB IN THE JUNGLE

Sitting in the back of the open jeep, C.T. balanced his journal on his knees and wrote about his unfolding adventure.

December 2 - Day 8 in Mexico. I'm off to Palenque. Grandpa checked with Mom, and she said it was O.K. So here I am with Terry and Victor, traveling all the way across three Mexican states.

They had left Cozumel early in the morning, taking the ferry to Playa del Carmen, then heading south and west toward Palenque. There was a lot to see and remember. Everything seemed very different from C.T.'s home in Ohio. *But I guess people are people*, he wrote. *I only wish I could speak their language.*

They drove for hours through miles of flat, jungle-covered countryside. Then, as they got closer to Palenque, the land grew more hilly, and the jungle was even thicker. It was nearly sunset when they arrived at the ruins of Palenque.

Terry's daughter Quiché was waiting to greet them. After everyone had a chance to say "*Hola*," Quiché offered to give C.T. his first tour of a Maya temple.

"The light's perfect right now," she said. So off they went, promising Terry they would be back before dark.

The first thing Quiché did was to order C.T. to stand still.

"What's going on?" C.T. asked, as Quiché tied a bandanna over his eyes.

"You'll see," Quiché said, grinning.

She took C.T.'s hand and led him carefully up a long, steep flight of stone steps. When they were at the top, she asked, "Now, are you ready to see Palenque?"

"I guess so."

With a flourish, Quiché took the bandanna from C.T.'s eyes.

There, spread out below were the remains of a vast ancient city. It gleamed in the light of late afternoon.

"Isn't it beautiful?" Quiché said softly.

C.T. had to agree. "Incredible!"

Early the next morning C.T. found Terry sitting on the great stone steps, sketching. He told her he'd tried to get Quiché up, without success. Terry smiled. "She got that from her daddy."

"He died, huh?" C.T. asked awkwardly.

"Yes," Terry answered. "Eight years ago. He was an archaeologist, too." She turned back to her drawing—a stone palace, colored in warm shades of orange, red and brown.

C.T. looked at the ruins, then back at the drawing. "Wow! That's what it looked like?"

"It's my best guess," said Terry, "from the evidence."

"What happened to the people here, anyhow? The Maya?" C.T. asked.

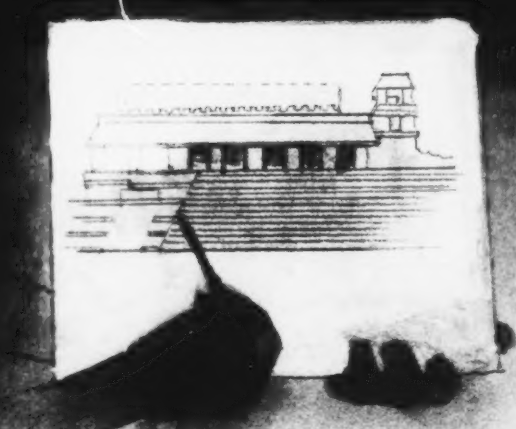
"If I could answer that one, I'd be in the Archaeology Hall of Fame," Terry said. "This was a grand city hundreds of years ago," she continued. "The [illegible] Maya civilization [illegible] ideas about why it happened [illegible]

She said she learned [illegible] that a climate change ruined the agriculture. Or maybe there was a social revolution, and the people abandoned the cities.

C.T. wanted to know how Terry could tell what the buildings used to look like.

"Come on," Terry said, smiling at his challenge. "Let's see if I can convince you."

Terry explained that one of her clues was the Mayas' use of symmetry. What they put on one side of a building, they usually put on the other side. Another clue was a fragment of the original paint used by the Maya. "The Maya made paints from soils and plants," she said. "I've made some of them myself to see what they looked like."



They came to a series of odd, T-shaped openings in one of the ancient walls. "What are these holes?" C.T.asked.

"Another mystery," said Terry. "Windows, maybe. A place to store things. We know that the T-shape was a sacred Maya symbol. They could have been a way to hang big plaster sculptures."

"But where are the sculptures?"

Terry's expression changed. "Oh, they've been looted long ago."

"Looters, huh?" C.T. peered into one of the openings. He tried to imagine the mysterious ancient people who had created this place, and the modern thieves who were now stealing from it.

Suddenly a head popped up on the other side of the opening. "Boo!" C.T. jumped back, startled. Quiché!

0S - 21

Terry suggested that Quiché show
around Palenque some more. The two
on a jungle trail. It took them over fallen
and under thick ropy vines. Huge
brushed their faces. From the canopy
overhead came strange noises.

Quiché gave C.T. a rundown on
tive animals. "Parrots, sloths, anteaters,
howler monkeys," she added, as a deep
low scream pierced the air.

The weird sound prompted C.T. to ask
there was anything dangerous in the jun

"Well, snakes," said Quiché. "One's
the two-step snake. That's how far th
you can get after one bites you!"

One of the places Quiché show
was the Temple of the Jaguar. "There u
be a carving of a jaguar up there," Quich
motioning toward the top of the temple,
"but the looters took it."

"Are there still looters?" he asked.

"Yes." Quiché's voice was solemn.
mom thinks looters may have killed my
He fell off one of the temples." Abrupt
changed the subject. "Come on. I have
Victor his lunch."

Victor was in a small clearing, lookin
through the lens of a surveyor's transit. A man
a short distance away moved a marker as
Victor signaled him. Another helper was
hacking a trail through the jungle with a
machete.

"*La comida*," Quiché announced.

"*Buenos dias*, Quiché," Victor said. "*¿Qué nos traes?*"

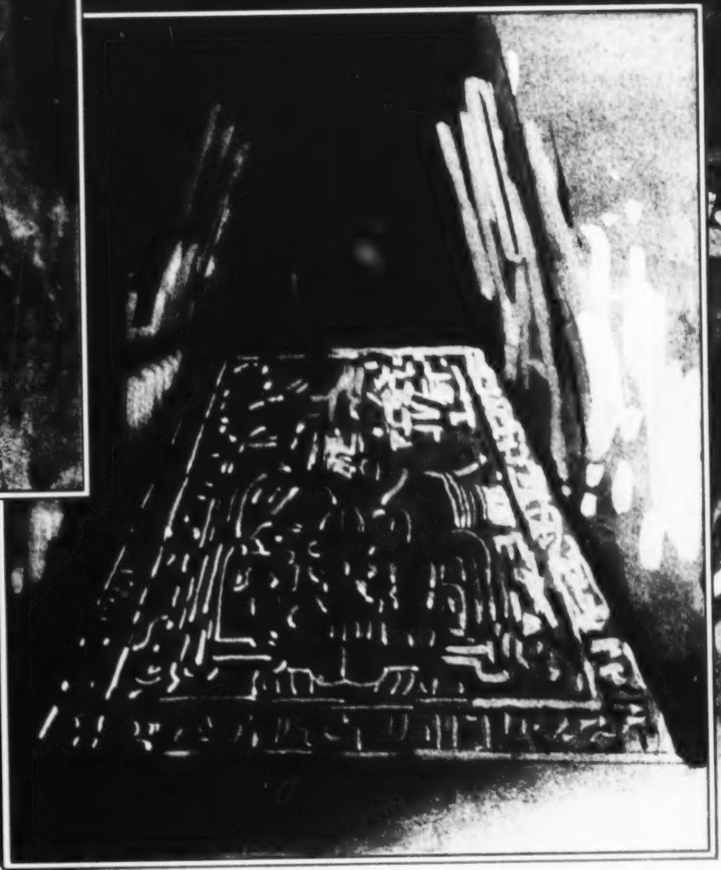
"*Frijoles, tortillas y refrescos.*"

"Ummm," said Victor, signaling that it was time for a lunch break. "*Buenos dias*, C.T.," he continued. "*¿Te gusta la selva?*"

C.T. hesitated, until Quiché translated, "Do you like the jungle?"

"*Si, mucho*," C.T. answered. He asked what Victor and his assistants were doing.

Victor explained that they were making a better map of the site. "Say this is an area of Palenque," he said, drawing in his notebook. "We use the transit to make lines through the jungle every fifty meters." He drew three horizontal lines and labeled them A, B and C. Then he drew vertical lines and labeled them 1,2,3. "If we find something here," he said, making a mark in one of the squares, "we can describe where it is by saying it's in square 3-B."



"I get it. Like graph paper," said C.T.

"Exactly," said Victor.

After lunch Quiché took C.T. back to what she called "the best part of Palenque," the temple she had shown him the night before. As they stood at the top, Quiché said, "About twenty-five years ago a guy named Ruz decided there was something inside this pyramid. He saw these holes in the floor." She pointed to the stone slab at their feet. "He figured the Maya used them to move this stone. So he moved it."

Retracing the steps of Ruz, C.T. and Quiché walked down the stone stairway he had dug out of the rubble. Soon they reached a stone landing.

"When he got here after two years of digging it looked like a dead end," Quiché said. "But he kept digging...for four years!" There was another set of steps. Down, down. Now they were deep inside the pyramid.

Q[illegible] [illegible]T. the huge triangle of stone that Ruz [illegible] discovered and moved. Behind it lay a huge limestone vault. "It's the tomb of Pacal! One of the kings of Palenque."

There was the massive stone slab that had rested on the **sarcophagus**. It was completely covered with carved pictures and Maya writing. Quiché read the **hieroglyphs**. "On the day 8 *ahau*, 13 *pac*, he was born. That means he was born on August 29, 603 A.D."

"And what did they find inside?"

"Pacal," said Quiché. "With a jade mask over his face!" They stood silently for a moment inside the dimly lit tomb. Finally, Quiché said, "Ready to go?"

"Yeah," C.T. said. "This place gives me the creeps."

Later in the afternoon, C.T. and the others relaxed on the temple steps. C.T. wanted to write about his day in his journal. "Terry," he asked, "the Maya had a calendar, right?"

"At least three different kinds," Terry answered. "They kept track of time, all right."

"Any idea what today is on any of them?" C.T. wanted to know. It would be neat to give his journal entry a date in Mayan.

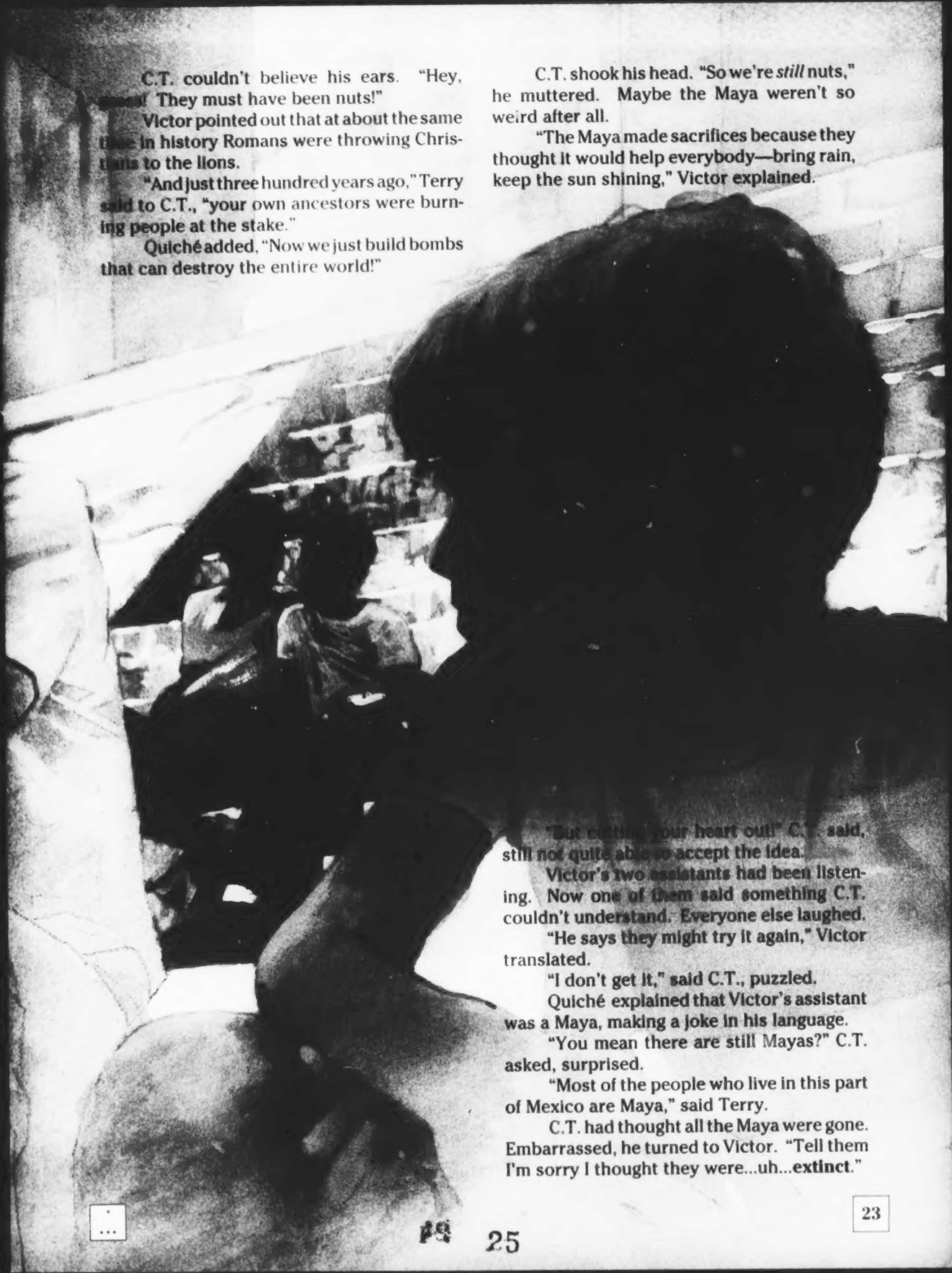
Before Terry could answer, Quiché spoke up. "Uh, 6 *cimi*, 19 [illegible] on the sun ritual calendar."

"Show off!" Terry said, giving her daughter a gentle nudge and smiling.

C.T. was curious about the religious ceremonies the ancient Maya used the temple for. Victor said the practices included bloodletting and human sacrifice.

"Human sacrifices?" C.T. was sure Victor was putting him on.

"I'm not kidding," Victor said. "They'd lay someone on a stone table up here, take an **obsidian** knife and cut out his heart. Still beating! Then they rolled the body down the steps..."



C.T. couldn't believe his ears. "Hey, [illegible]! They must have been nuts!"

Victor pointed out that at about the same time in history Romans were throwing Christians to the lions.

"And just three hundred years ago," Terry said to C.T., "your own ancestors were burning people at the stake."

Quiché added, "Now we just build bombs that can destroy the entire world!"

C.T. shook his head. "So we're *still* nuts," he muttered. Maybe the Maya weren't so weird after all.

"The Maya made sacrifices because they thought it would help everybody—bring rain, keep the sun shining," Victor explained.

"But cutting your heart out!" C.T. said, still not quite able to accept the idea.

Victor's two assistants had been listening. Now one of them said something C.T. couldn't understand. Everyone else laughed.

"He says they might try it again," Victor translated.

"I don't get it," said C.T., puzzled.

Quiché explained that Victor's assistant was a Maya, making a joke in his language.

"You mean there are still Mayas?" C.T. asked, surprised.

"Most of the people who live in this part of Mexico are Maya," said Terry.

C.T. had thought all the Maya were gone. Embarrassed, he turned to Victor. "Tell them I'm sorry I thought they were...uh...**extinct**."

—ACTIVITY—

¿Habla Usted Mayan?

Hax tube!
Yum botic.

There are about twenty different Mayan languages spoken today in Mexico, Guatemala, and Honduras. The most common one, Yucatec Mayan, is spoken in "The Second Voyage of the *Mimi*." Many Maya children speak Mayan at home and Spanish in school. You can learn some Yucatec Mayan, too.

How to pronounce Mayan words

"a" = "ah" as in "calm"
"e" = "eh" as in "effort"
"i" = "ee" as in "keen"
"o" = "oh" as in "open"
"oo" = the same sound as "o" but it's held a little longer
"u" = "oo" as in "moon"
"x" = "sh" as in "bush"

An apostrophe (') means to make a sudden stop between sounds where it occurs in a word.

T'ux ka binex?
Kin bin in escuela.
Koox tun.

MAYAN	ENGLISH
Bix a belex?	How are you?
Maloob.	I'm fine (or I'm okay).
Tu'x ka binex?	Where are you going?
Kin bin tin nah.	I'm going home.
Kin bin in "escuela."*	I'm going to school.
Koox tun.	Let's go then.
Yum botic.	Thank you.
Mixba.	You're welcome.
Hax tube.	That's perfect.

*"Escuela" is the Spanish word for "school." The Maya did not have a word for it.

Practice saying these words in Mayan. See if you can have a conversation with a friend using them. The Maya characters use some of these words in "The Second Voyage of the *Mimi*."

There are also lots of Spanish phrases in the story. C.T. learns how important it is to know other languages during this voyage. Victor is Mexican, but he learned to speak Mayan from his grandfather. So, he is **fluent** in Spanish and Yucatec Mayan. Do you have any relatives who speak another language? What languages are spoken in your family?

Who's a Maya?

The ancient Maya were groups of Native Americans who lived in parts of Mexico and Central America over two thousand years ago. Their civilization reached its height around 900 A.D., five hundred years before Columbus "discovered" the "New World." Their monuments, paintings, and books are the earliest written history of the Western Hemisphere.

The Maya invented accurate calendars based on observations of the sun, the moon, and the planet Venus. They were excellent at mathematics and they developed a hieroglyphic written language.

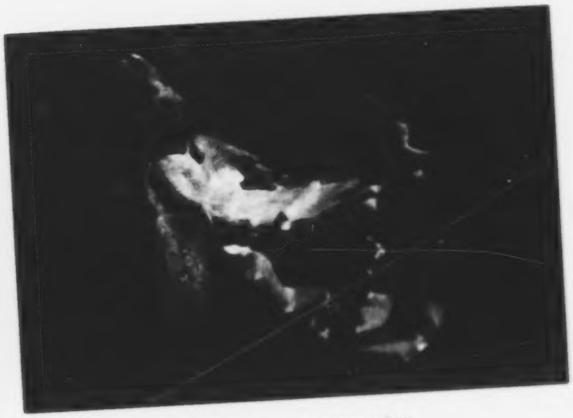
Today, many Maya still live in Mexico and Central America. Some live and farm in tiny villages, much as their ancestors did. Others live and work in modern cities. We learn much about the ancient Maya by studying the objects and buildings they created. In recent years, we've gotten better at **deciphering** their hieroglyphics, but there is still much to be learned.

Stone "torchbearer," Copán, Honduras.

Stone "captives," Palenque, Mexico.

Figurine with headdress removed.

Ceramic figurine of seated lord with headdress.



Ceramic figurine of woman weaving.

EXPEDITION

Based on his first visit with Murray Hamlett at the U.S. Army Research Institute for Environmental Medicine, Ben Affleck was nervous about what was in store for him.

CLIMATIC
CHAMBERS

Ben Affleck first visited the U.S. Army Research Institute of Environmental Medicine in Natick, Massachusetts, a few years ago to learn about how our bodies react to cold weather. After being in Mexico's hot climate for a few months, he went back there to learn about what heat does to us.

This time Ben was a little worried. On the first "Voyage of the *Mimi*," Dr. Murray Hamlett took him into an arctic wind tunnel, *without a jacket*, to see how quickly the temperature dropped on different parts of his body.

But Dr. Hamlett reassured him. "If it's any comfort to you, I'm not the expert on heat around here."

Dr. Roger Hubbard *is* the heat expert at Natick. He studies the effects of heat on people and equipment by putting them in a tropic wind tunnel. The tropic wind tunnel can heat up to 165 degrees Fahrenheit, with **humidities** as high as 90 percent and wind speeds up to 40 miles per hour.

Ben had already learned about the danger when the body's **core temperature** drops too low. Now he wanted to know if it was also dangerous if the core temperature got too high.

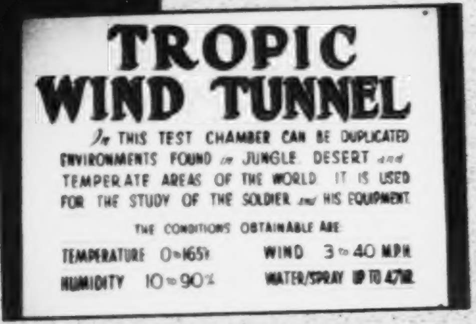
The core temperature is the temperature deep inside our bodies. The body regulates its core temperature over a very narrow range. It can't get too high or too low or our organs won't work right. Our bodies are always making heat by burning or **metabolizing** the food we eat. If we weren't always losing heat, we'd get too hot.

"How does the body get rid of heat?" Ben asked.

"Simple—blood and sweat," said Roger. The body pumps warm blood from the core to the skin, where heat can escape into the environment. When the weather is very hot or you work in a warm environment, the body pumps more blood to the surface of the skin. That's why the body looks flushed when it's overheated.

Sensors would monitor Murray's heart rate, skin temperature and core temperature in the tropic wind tunnel.

The temperature can reach 165° F, and the humidity can reach 90%.



TROPIC
WIND TUNNEL

In THIS TEST CHAMBER CAN BE DUPLICATED ENVIRONMENTS FOUND in JUNGLE, DESERT and TEMPERATE AREAS OF THE WORLD. IT IS USED FOR THE STUDY OF THE SOLDIER and HIS EQUIPMENT.

THE CONDITIONS OBTAINABLE ARE:

TEMPERATURE 0 to 165°F
WIND 3 to 40 M.P.H.
HUMIDITY 10 to 90%
WATER/SPRAY UP TO 4"/HR.

"I understand how your body can lose heat when the air around you is under 98 degrees," Ben said. "But how would you lose heat if you were in that chamber where it's 100 degrees?"

"Well, the best way to find that out is to put a body, or **guinea pig**, in the chamber," suggested Roger.

"Does it have to be *my* body?" Ben asked.

Remembering his first visit to Natick, Ben's idea of the perfect guinea pig for this experiment was Dr. Hamlett. "Turnabout's fair play, Dr. Hamlett," Ben chuckled.

Dr. Larry Armstrong, an expert in sports medicine, helped Murray get ready for the test chamber. He connected **sensors** to measure Murray's heart rate and skin temperature.

Murray in the tropic wind tunnel.

To measure core temperature, a **lead** was inserted through Murray's nose, down through the **esophagus** and stopped at a level near the heart. Murray assured Ben that the **apparatus** wasn't *too* uncomfortable. The temperature in the chamber was set at 100 degrees Fahrenheit, but the air was very dry. Larry plugged in the sensors.

After Murray had been in the chamber for about twenty minutes, they checked the data on the graph. "His skin temperature seems to be going up and down. Why is that?" Ben asked.

Roger explained that when Murray first went into the chamber, his skin temperature rose. Then he began to sweat. As the sweat evaporated, his skin temperature fell, so he stopped sweating. So the temperature change showed a cycle that is the body's response to heat: sweating, evaporative cooling, not sweating until the skin temperature rises again, then sweating again.

Murray's core temperature was rising, but only slightly. Evaporative cooling occurring on Murray's skin was compensating for the heat gained from the environment, balancing heat gain and heat loss very well.

The dry air in the chamber made Murray's sweat evaporate quickly. And it's the evaporation that cools you, not just the sweat sitting there on your skin. When water turns from liquid to **vapor**, or evaporates, it takes heat. So your skin cools, the blood under the skin gives up heat and circulates back to your core.

Ben walked into the chamber. "Hey, it's not too bad in here," he said.

Murray explained, "Because of the very low humidity, the evaporation of sweat from the skin is working well to keep me dry. It's always more comfortable in a hot, dry situation than it is in a hot, humid situation."

They decided to make Murray do some work—walking on a treadmill—to see how that would affect his core temperature. Exercise causes your muscles to make extra heat that you have to get rid of. The muscles also need more blood to bring them oxygen. So now the heart has to pump hard to get blood both to the muscles that are doing the work and to the skin, to help keep your core cool.

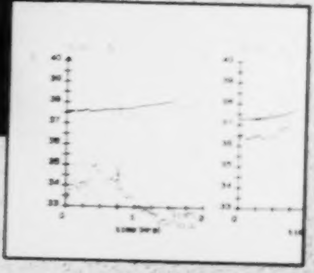
It didn't take long to see the effects. Murray's heart rate was 85 when he entered the chamber. After he'd been standing for forty-five minutes in the heat, it went to 114. Now, after he'd been walking for fifteen minutes, his heart rate was about 126.

Murray's heart was doing its job and so was his sweat. His core temperature was rising, but only about 1 degree Fahrenheit. His skin temperature was actually falling because of the evaporation of his sweat. Without the cooling effect of sweating, his core temperature would rise faster. If he were working in a humid environment, his core temperature would rise even more quickly because his sweat wouldn't evaporate as much.

So they decided to see what would happen if Murray's sweat wasn't cooling him much. Same temperature—100 degrees Fahrenheit—but this time they made the air very humid. Sweat won't evaporate into air that already has a lot of water vapor in it.

Roger, Larry, and Ben check the readings.

The graph on the right shows the effects of exercising in the hot, humid environment on Murray's core and skin temperatures.



"Whoa, it's hot!" said Ben as he entered the chamber. The high humidity made 100 degrees feel hotter. Even without doing any work, Murray was covered with sweat. He was getting no evaporative cooling.

Seeing how heat and humidity were affecting Murray, Ben wondered how animals other than humans cool themselves.

Murray described some of the different ways other animals get rid of body heat. Birds have an internal cooling system—air sacs inside their bodies that connect to the lungs. Because they're so well insulated on the outside, they have internal radiation surfaces. Elephants have big ears with a large surface area that they flap in the breeze to get some radiant heat loss.

One angry cold weather expert.

Other animals pant. Breathing rapidly over the tongue and **mucous membranes** causes evaporative cooling. Dogs lose over 90 per cent of their body heat by panting. They also lose some heat through their foot pads. Cats are really desert animals and are very well adapted to hot environments. They lose heat off their ears and they get some evaporative cooling from licking themselves. But most of their heat loss is through panting.

"How can fur animals stay cool at all?" Ben wanted to know.

"Fur insulates animals from both directions, so that if the outside air temperature is higher than the body temperature of the animals, the fur insulates them from heat gain from the environment." Murray went on to explain that most animals hide underground or in dens when it gets hot. They are relatively inactive and drink lots of water.

Beads of sweat were forming on Ben's face. Murray was covered with sweat. A person can sweat up to two or three quarts an hour. Sweat is mostly water, so it's important to drink a lot of water in hot weather or when you're exercising.

They turned on the treadmill again so Murray could start working in the hot, humid environment. He felt his heart rate and temperature go up. He was pretty uncomfortable. "I can only do this so long. As I **shunt** blood to other parts of my body—that is, move blood from my muscles and out to my skin—my blood pressure might drop significantly and I might get lightheaded and collapse or faint."

Ben left the chamber to check the graphs. Murray's core temperature was rising steadily. His heart rate was up to 134. His skin looked flushed.

"How high can your heartbeat get before it becomes dangerous?" Ben asked Larry.

"During our studies, we have a limit of 180 beats per minute. That's a very healthy exercise rate." They also carefully monitor core temperature. A core temperature above 107 degrees Fahrenheit can be very dangerous, and brain damage could result.

"His skin temperature and core temperature are very close. I think we ought to get him out of there," said Larry.

"You're looking at one very angry cold weather expert," Murray said when he came out of the chamber. "Well, are we even Ben?"

"Yes, I think we're even," Ben said as he and Murray shook hands.

HOW DRY AM I?

Did you know that you sweat up to half a cup of liquid in an hour—even on a cool day? (Adults lose up to one cup an hour.) Playing outside on a hot day, you can lose up to four cups of liquid an hour. How much do you think you sweat in an entire day of hot weather? of cool weather? If you're sweating so much, why aren't your clothes always wet?

It's important to replace all the liquids the body loses during the day. You should drink before, during and after exercising or playing, especially when it's humid and hot.

Tiny amounts of salt and other minerals are lost when you sweat. However, a normal, healthy diet contains enough salt and minerals to replace them. You don't need to take salt tablets or special drinks to make them up.

Try weighing yourself before and after exercising or playing outside in summer. You may find that you've lost up to a pound. What you've lost is water, not fat, so drink up! It's not healthy to be all dried up!

EPISODE

A LIGHT IN THE DARK

Captain Granville was happy to be at sea again, steering *Mimi* across the clear, sparkling channel that separated Cozumel Island from the Yucatán Peninsula. Happy and hungry.

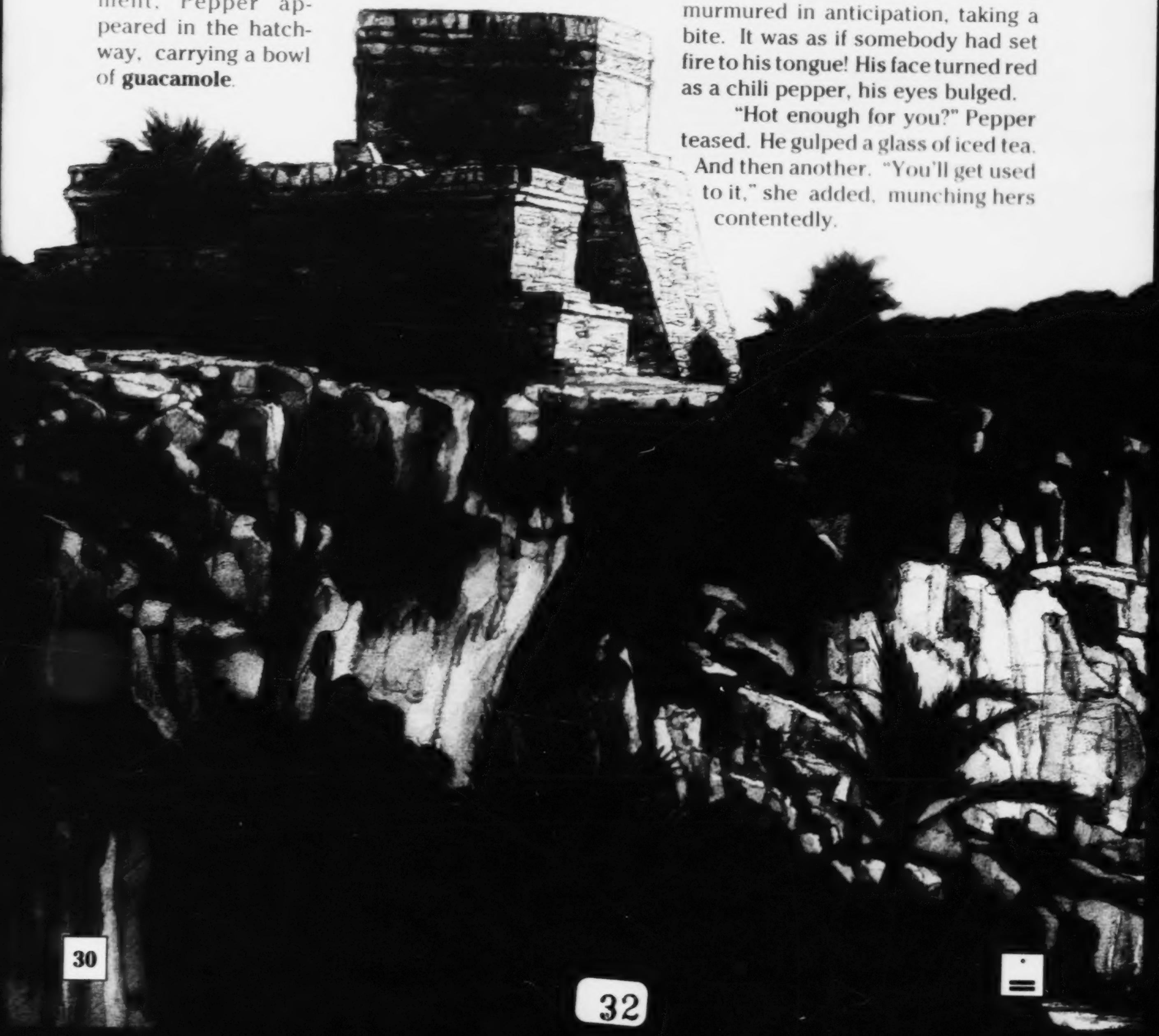
"Hey, what happened to my navigator?" he said. At that moment, Pepper appeared in the hatchway, carrying a bowl of **guacamole**.

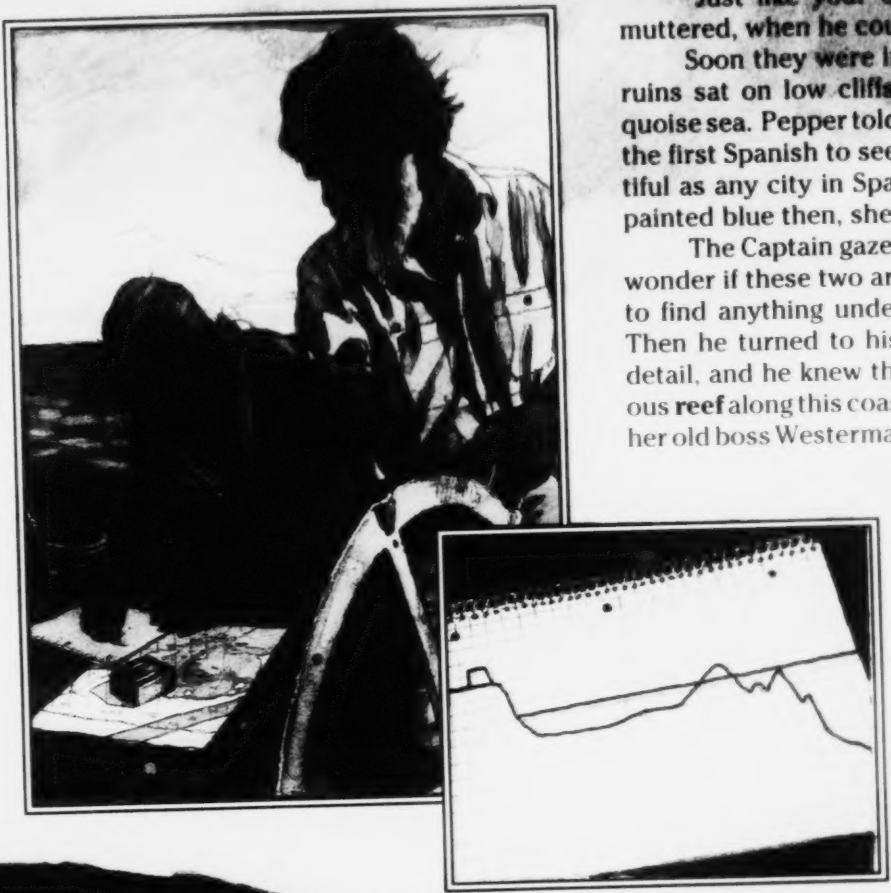
"Texas-style. Hot enough to clean your teeth," she announced.

The Captain handed the wheel over to his new first mate. Grabbing a tortilla chip from C.T.'s pot, he scooped up some of the green dip.

"Um-umm, guacamole," he murmured in anticipation, taking a bite. It was as if somebody had set fire to his tongue! His face turned red as a chili pepper, his eyes bulged.

"Hot enough for you?" Pepper teased. He gulped a glass of iced tea. And then another. "You'll get used to it," she added, munching hers contentedly.



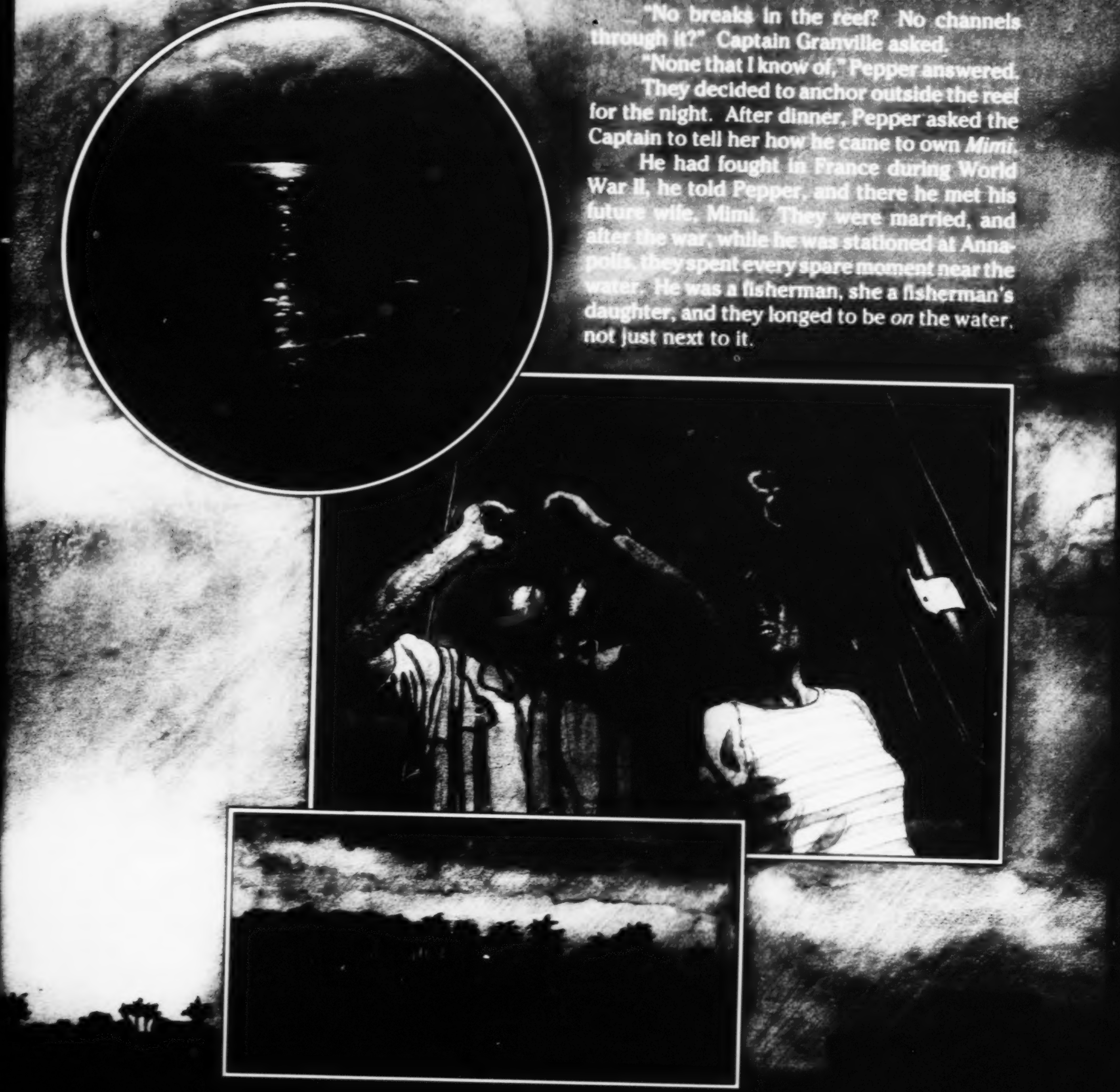


"Just like your old man," the Captain muttered, when he could speak again.

Soon they were in sight of Tulúm. The ruins sat on low cliffs, overlooking the turquoise sea. Pepper told Captain Granville that the first Spanish to see it said it was as beautiful as any city in Spain. The temples were painted blue then, she said.

The Captain gazed at the ancient city. "I wonder if these two archaeologists are going to find anything underwater here," he said. Then he turned to his charts. They lacked detail, and he knew that there was a dangerous **reef** along this coast. Pepper told him that her old boss Westerman had carefully charted these waters, but that he kept those charts for his own use.

She had done some diving in the area, so she was able to draw a picture of the reef. It could provide a nice calm anchorage if they could get through it without ripping the belly out of *Mimi*.



"No breaks in the reef? No channels through it?" Captain Granville asked.

"None that I know of," Pepper answered.

They decided to anchor outside the reef for the night. After dinner, Pepper asked the Captain to tell her how he came to own *Mimi*.

He had fought in France during World War II, he told Pepper, and there he met his future wife, Mimi. They were married, and after the war, while he was stationed at Annapolis, they spent every spare moment near the water. He was a fisherman, she a fisherman's daughter, and they longed to be *on* the water, not just next to it.

One day they spotted a beautiful old French **trawler** tied up along Weems Creek. The man who had sailed the boat over from France had gone broke and needed to sell her. They managed to scrape **the money together**, and soon they were living on board.

His reminiscing was suddenly interrupted by the distant throttle of a boat's engine. They climbed up on deck and peered into the night. As their eyes adjusted to the dark they were astonished to see a powerful motor yacht heading out from the shore.

"That's a very big boat to be inside the reef," Pepper exclaimed.

"Let's ask them how they got in there," Captain Granville said. "Crank her up. I'll [illegible] the anchor."

In a [illegible] Captain kept his [illegible] their boat. He couldn't understand why they were running dark—no lights at all. Strange. "Either they know where there's a channel through the reef, or [illegible] to be fishing for survivors," he said.

Suddenly the boat was very near, crossing their bow. "Ahoy there!" the Captain shouted. *"¡Buenas noches, señores!"*

There was no response from the darkened boat, only a loud splash and the sound of somebody shouting. Somebody angry, it sounded like. The boat's engines revved as it cleared the reef, and soon the night had swallowed all traces of it.

"Try and stop her right here," the Captain shouted, and Pepper cut *Mimi*'s engine. He swept the water with his binoculars. *Surely there's a buoy to mark the channel*, he thought, but he could find no marker. *How on earth did they get through?*

His thoughts were interrupted when he noticed a glimmer of light on the cliff. The light flickered for a moment, and then disappeared. "Back her down," he called to Pepper, and the light reappeared as she slipped *Mimi* into reverse. "Well, well," the Captain murmured.

He had Pepper ease the boat back and forth a few more times, and on each pass the light would appear for a few seconds and then vanish. "See something?" Pepper asked.

"Just a light on the cliff," he answered. "We'll check it out in the morning. Let's anchor right here."

Pepper was ready to turn in. She thanked the Captain for the stories he'd told her. "It's great to get to know my pop's old buddy."

"Tell you what," he said. "Since I call you by your nickname, and your old man has spilled the beans about mine..."

Pepper smiled. "Goodnight, Granny," she said.

"Goodnight, Pepper."

Tulúm was alive with tourists the next morning, climbing up and down the weathered steps that had been climbed for centuries. Captain Granville separated himself from the crowd and wandered off towards the edge of the site. It was a beautiful place, dotted with palm trees and tropical flowers. Below the ruins was a perfect little beach where he had come ashore earlier. The green water was the clearest he'd ever seen. He wondered what had happened to the people who once inhabited this spectacular city.

He found what he was looking for on a windy bluff: the ashes of a fire, still warm in his hands. He looked up and saw a tiny temple standing at the edge of the cliff. The one wall that was still standing had a window in it, and through it he could see *Mimi*, resting at anchor just outside the reef.

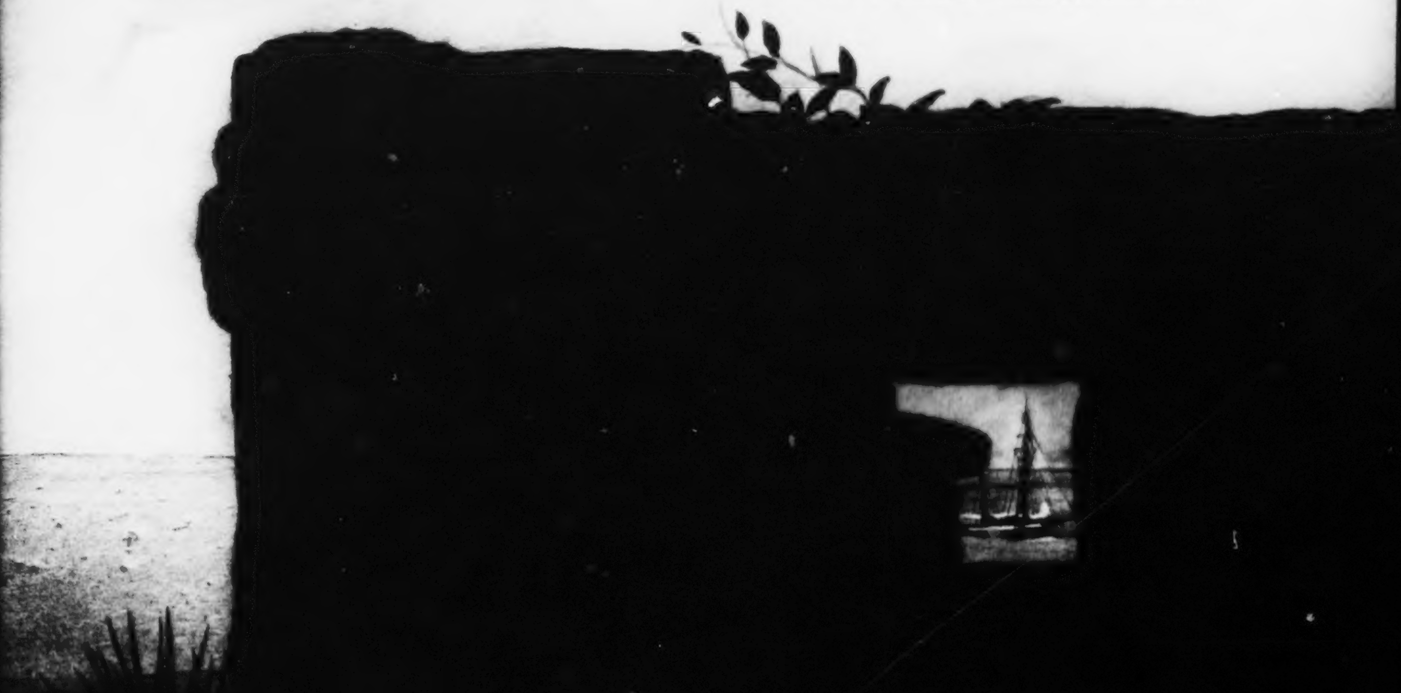
He moved slightly to his left, and *Mimi* disappeared. He shifted to his right, and lost sight of the boat again. Only by spotting directly across the fire could he keep *Mimi* in view through the window.

"*Señor. . .*"

Captain Granville looked up to see a dark-haired man staring down at him. "It is forbidden to start fires in an archaeological zone," the man said in a stern voice.

Just as the Captain began to explain, Victor and Terry arrived. "I'm glad you came," the Captain said. "I was having a little trouble explaining to the guardian about what I..."

"Guardian?" Victor interrupted, smiling. He introduced Captain Granville to Tomás Segovia, the chief archaeologist at Tulúm. They laughed off the misunderstanding, and the Captain recounted the story of the mysterious boat the night before. He believed the fire and temple lined up to form a kind of lighthouse that marked a passage through the reef.



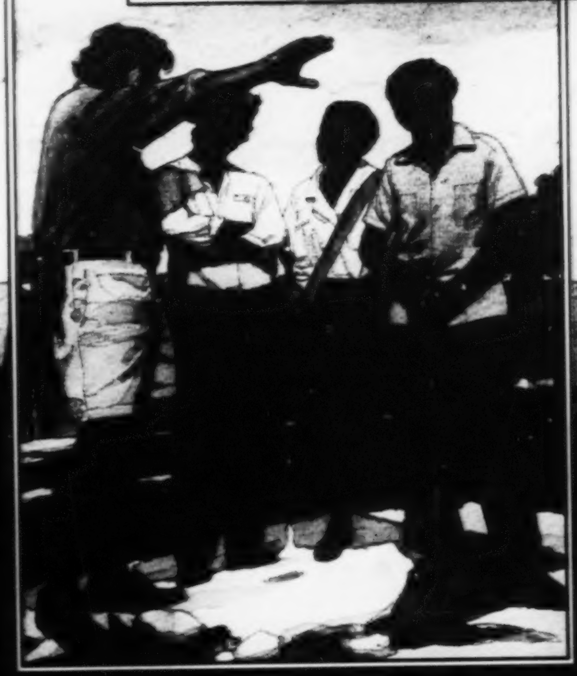
The others looked doubtful, but the Captain persisted. "If you're on a boat out there, and you can see the light from the fire through the small window in the temple, you're on the right course to get through the reef."

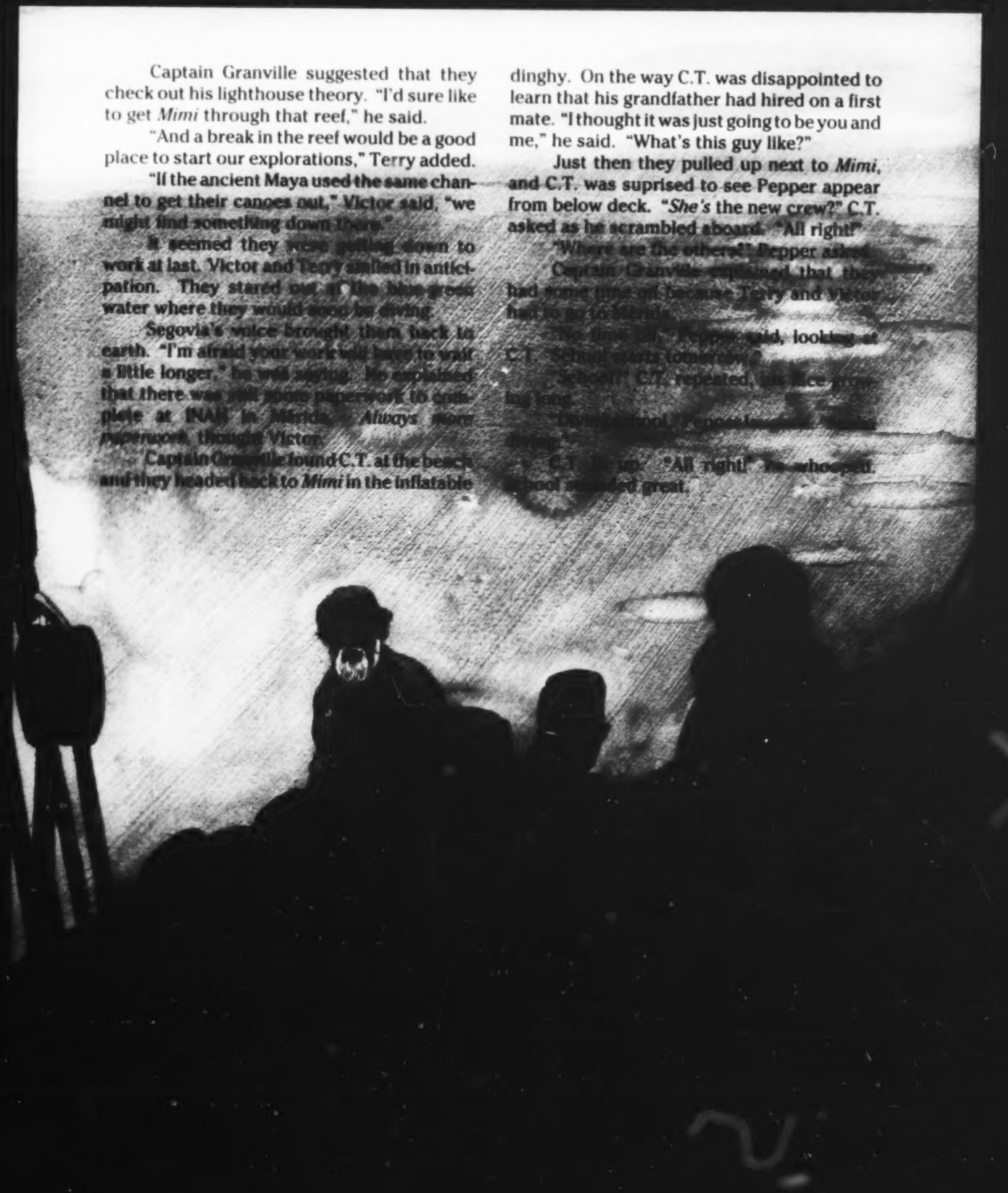
Now Victor and Terry were intrigued. "The ancient people could have done the same thing!" Victor said.

"No, no, Victor, I am afraid not," Segovia said, chuckling. His theory was that the temple was used by the ancient Maya to mark the sunrise on the first day of winter.

Smiling, Victor shook his head. "Segovia believes that every temple was built to mark the movement of some star," he said to Captain Granville. "The Maya were terrific astronomers, it's true. They figured out how to predict the movement of the sun and planets, but Maestro here believes that's all they did."

"We disagree with him," Terry said, joining the debate. "The trouble is, he keeps discovering some very good evidence."





Captain Granville suggested that they check out his lighthouse theory. "I'd sure like to get *Mimi* through that reef," he said.

"And a break in the reef would be a good place to start our explorations," Terry added.

"If the ancient Maya used the same channel to get their canoes out," Victor said, "we might find something down there."

It seemed they were getting down to work at last. Victor and Terry smiled in anticipation. They stared out at the blue-green water where they would soon be diving.

Segovia's voice brought them back to earth. "I'm afraid your work will have to wait a little longer," he was saying. He explained that there was still some paperwork to complete at INAH in Mérida. *Always more paperwork,* thought Victor.

Captain Granville found C.T. at the beach and they headed back to *Mimi* in the inflatable dinghy. On the way C.T. was disappointed to learn that his grandfather had hired on a first mate. "I thought it was just going to be you and me," he said. "What's this guy like?"

Just then they pulled up next to *Mimi*, and C.T. was suprised to see Pepper appear from below deck. "*She's* the new crew?" C.T. asked as he scrambled aboard. "All right!"

"Where are the others?" Pepper asked.

Captain Granville explained that they had some time off because Terry and Victor had to go to Mérida.

"No time off," Pepper said, looking at C.T. "School starts tomorrow."

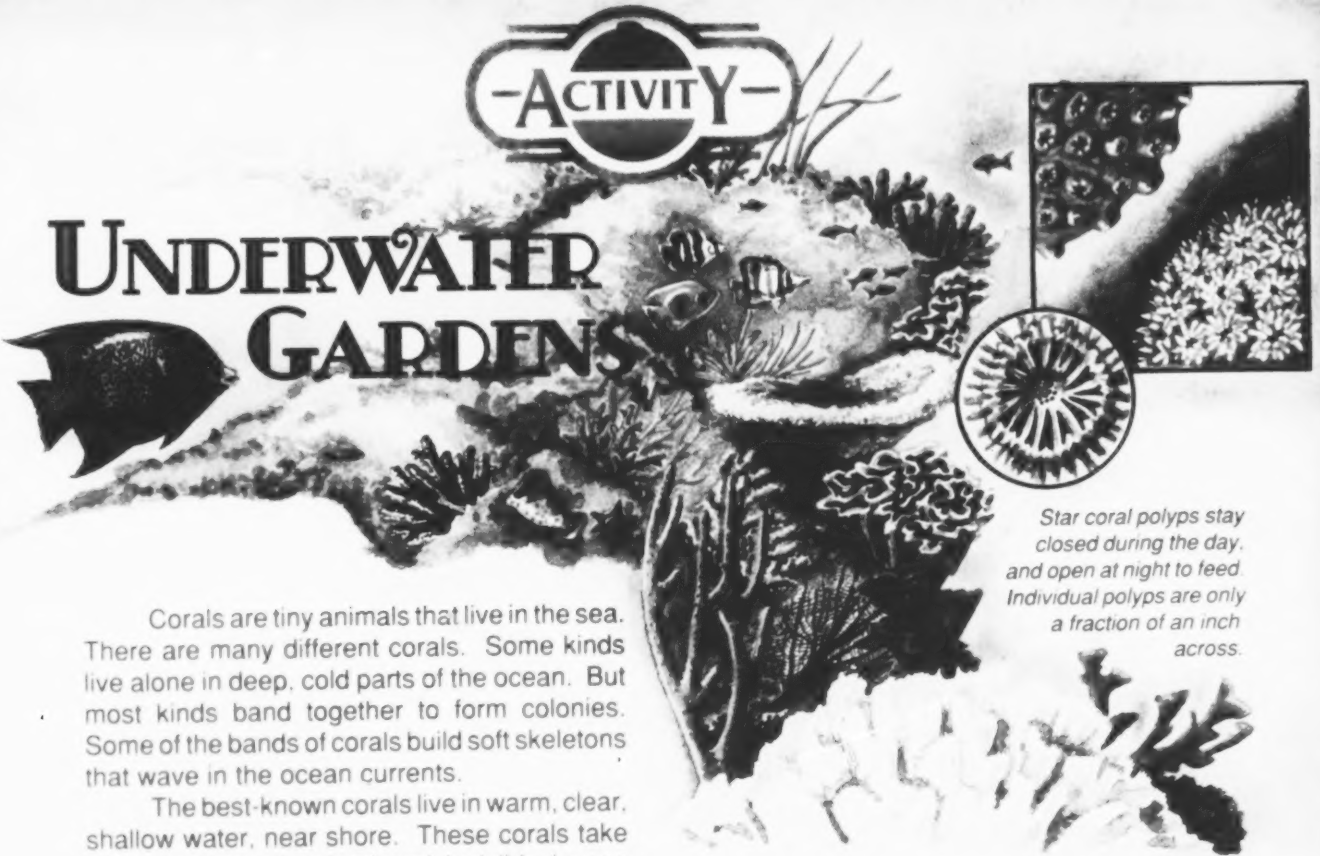
"School?" C.T. repeated, his face growing long.

"Diving school," Pepper laughed. "[illegible] diving."

C.T. lit up. "All right!" he whooped. School sounded great.

-ACTIVITY-

UNDERWATER GARDENS



Star coral polyps stay closed during the day, and open at night to feed. Individual polyps are only a fraction of an inch across.

Corals are tiny animals that live in the sea. There are many different corals. Some kinds live alone in deep, cold parts of the ocean. But most kinds band together to form colonies. Some of the bands of corals build soft skeletons that wave in the ocean currents.

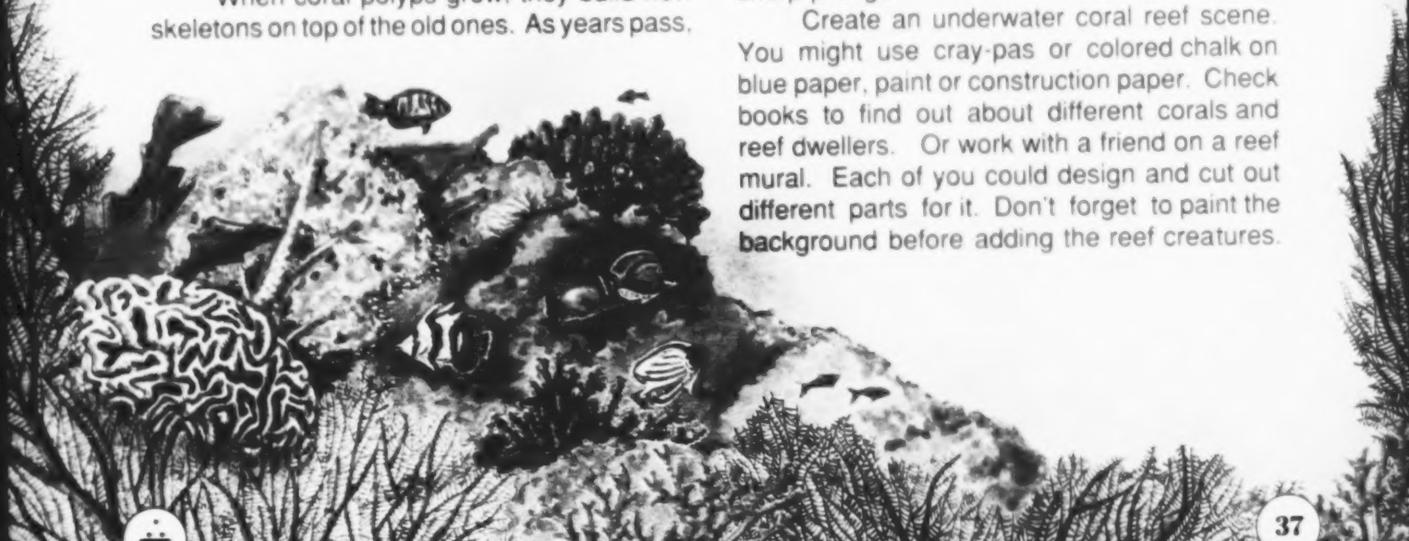
The best-known corals live in warm, clear, shallow water, near shore. These corals take calcium that's dissolved and invisible in sea water and use it to form colorful, stony skeletons. The skeletons of the tiny animals join together.

The coral animals (called **coral polyps**) live inside their skeletons. They have soft, cup-shaped bodies with **tentacles** on the top. At night they extend their tentacles and feed on tiny floating ocean animals. During the day, the tentacles are pulled in and the polyps close up. It's hard to know the coral is alive during the day.

When coral polyps grow, they build new skeletons on top of the old ones. As years pass, huge underwater structures are formed this way. These structures are called coral reefs. The reef corals are many different colors and shapes. Thousands of brightly colored fish and other fantastic-looking creatures live in the nooks and crannies of coral reefs.

Some coral reefs form parallel to the shore and a few miles out. Before good maps were drawn, these "barrier reefs" caused many shipwrecks as boat bottoms were pierced by their sharp prongs.

Create an underwater coral reef scene. You might use cray-pas or colored chalk on blue paper, paint or construction paper. Check books to find out about different corals and reef dwellers. Or work with a friend on a reef mural. Each of you could design and cut out different parts for it. Don't forget to paint the background before adding the reef creatures.



Ben Affleck returned to Tulúm, Mexico, a year after "The Second Voyage of the *Mimi*" was filmed. He went to meet the *real* archaeologist named Segovia. The Segovia in the story of "The Second Voyage of the *Mimi*" was made up, but he was modeled on a real person named Victor Segovia. The real Segovia really does believe that some of the buildings at Tulúm were used to mark the appearance of the sun on certain days.

Keeping track of the sun can help us keep track of time. Segovia reminded Ben that the earth travels around the sun. One trip around the sun equals one year. Segovia thinks the Maya could tell almost exactly when the earth completed one trip around the sun.

It's hard to imagine being able to tell how long a year is just by looking for clues in nature. Segovia said Ben could do the same thing if he didn't sleep so late every morning. If he got up early enough, he would see that the sun comes up in a slightly different place every day.

The sun does come up in the east, but not always due east. In fact, on the first day of winter, called the winter **solstice**, the sun rises pretty far to the right, or south, of due east. Then, each day the sun rises slightly further to the north, little by little, until the first day of summer. On that day, the summer solstice, the sunrise starts moving back to the south again. Each day the sun rises a little further south, until, on the next winter solstice, it rises just where it started exactly one year earlier.

Segovia thinks the Maya could tell when the winter solstice occurred. He thinks they placed a small temple in exactly the right spot, so that if they sat on a special "throne" built in the wall surrounding Tulúm, they could sight the sunrise through the temple, but only on that one day—the first day of winter. Then they'd know when another year had passed.

Ben Affleck and Victor Segovia (the real Segovia) at Tulúm.

Ben and Segovia sat on that throne on December 21st, the first day of winter, waiting to see the sunrise and test the theory. Segovia thinks the Maya waited for sunrise in the same spot at least seven hundred years ago. Many people question his theory. "They think I am crazy," he laughed.

However, as the sun rose that morning, it was perfectly framed by the arch of the temple. As Ben watched the spectacular sight, he had to admit the theory made sense. "Wow! That's perfect!" he exclaimed.

We can never know for sure, but it looked like the Maya were good astronomers—measuring the year by keeping track of where the sun rose.

The sun is framed by the temple.

Dawn on the winter solstice at Tulúm.

The real Segovia's theory could be true.

The earth also spins around or **rotates**, like a top, once every day, 365 days a year. That helps us keep track of time, too. Ben visited the Royal Observatory, near London, in Greenwich, England, where astronomers have been timing the spin of the earth by keeping track of the sun for over three hundred years.

The journey itself taught Ben a lesson about time and the earth's rotation. Ben left his home in Boston at night. By the time he reached London, it was morning. At about ten o'clock, he decided to call home. His little brother answered the phone in a sleepy voice and asked, "Ben, do you know what time it is?"

Ben answered, "Sure. It's about ten in the morning here, there's a five-hour time difference...it must be about three in the afternoon over there. Why aren't you in school?"

Casey replied grumpily, "It's not three in the afternoon. It's five o'clock in the morning!"

"Uh-oh," said Ben, "I think I miscalculated. Sorry."

Ben knew there was a five-hour time difference between Boston and London. However, he added hours when he should have subtracted. Luckily, he had an appointment at the Royal Observatory in Greenwich later that morning so he could try to straighten out his confusion.

Ben met Dr. Stuart Malin, the head of the Observatory, who used a lamp and a globe in a darkened room to show Ben why he got confused. "This is roughly what the earth would look like from space," Stuart said.

One half of the globe was illuminated by the lamp and the other half was totally dark.

WESTMINSTER
CROYDON

Ben went to England to learn about other ways of using the earth and sun to keep track of time. The journey itself taught him a lesson about time.

The side facing the lamp (or the sun) would be in daylight and the side away from the lamp would be experiencing night. Since the earth is constantly spinning, the area facing the light keeps changing.

As the earth rotates to the east, there is an edge between darkness and light. On the side of the globe turning toward the light, that edge would be sunrise, six o'clock in the morning. On the other side, the sun would be setting, six o'clock at night. At the part of the globe in the middle of the dark side, we say it is midnight. In the middle of the light side, we say it is noon.

"If I imagine myself standing right here in Boston and then just kind of rolling toward the sun at sunrise...it's not like the sun is coming up—but more me moving toward the sun, then away from it and back to it again," Ben said.

Stuart demonstrated, using the globe, that at ten o'clock in London, the sun has not yet risen in Boston.

Stuart Malin helped Ben understand how the earth's rotation causes day and night.

Ben was beginning to see why we have to set our clocks to different hours at different places on earth.

Ben realized that there had to be some way to **synchronize** the world's clocks. To do that, someone had to keep track of time for the world. For hundreds of years, the astronomers at Greenwich have done just that. They set the observatory clock every day by using a telescope to determine the exact moment when the noonday sun passed over an imaginary line called the Greenwich **meridian**. The meridian is marked by a brass rail in the ground. The telescope is set right on the meridian.

The next morning, Ben stood on the Greenwich meridian with Carole Stott, the curator of astronomy at Greenwich. She said that at noon, his shadow would fall right on the meridian. Since it was before noon, his shadow was on an angle several feet from the meridian.

Estimating the distance, he guessed it was about ten o'clock. Carole checked her watch and congratulated him. The human **sundial** was only about five minutes off. She said, "A sundial is, in a lot of ways, the most accurate way of keeping time, because you're using the basic time-keeper, which is the rotation of the earth."

The Greenwich astronomers used that basic time-keeper back when they were telling the rest of the world how to set their clocks. Carole showed Ben how they used to do that. Near noon, she cranked open the roof of the observatory so the big telescope inside could be focused on the sun. Carole adjusted it to the right height for the sun that day and focused it.

Looking at the sun can injure your eyes or blind you. This telescope is equipped with special lenses so the astronomers can safely look at the sun.

Ben looked through the telescope and saw a series of black lines. The center lines represented the Greenwich meridian. As he watched, the sun came into view in the telescope and moved across the lines until it was framed between the center lines. That meant it was exactly noon, Greenwich time. Ben ran outside and stood on the Greenwich meridian. His shadow was right on the line.

The next thing the Greenwich astronomers would do each day, once they had noted noon, was to correct their own clock. Then they would let everyone else in the area know

As noon approached, Ben observed the sun through the big telescope.

At noon Greenwich time, Ben's shadow aligned with the Greenwich meridian.

the correct time by hoisting a big ball to the top of a mast on one of the buildings. At exactly one o'clock, the ball would drop down the mast and people around Greenwich and London could set their clocks. People nearby still use the time ball to set their watches. But the old telescope at Greenwich has given way to more modern instruments. Still, the only way to keep our clocks and calendars perfectly accurate is by watching the way the earth moves.

WHAT TIME IS IT, REALLY?

A little over one hundred years ago, there was no standard time in the United States. People all set their watches to noon when they thought the sun was at its peak in the sky. So people in different towns all had different noons.

This was an awful problem for the people running railroads. How could they make schedules when in Wisconsin alone there were thirty-eight different local times?

A school teacher named Charles Dowd met with railroad officials and they came up with a plan. They divided the United States up into four time zones. The width of each zone was determined by the distance the sun seems to travel in one hour—about fifteen degrees of longitude. Boundaries were drawn and Eastern, Central, Mountain and Pacific time zones were established on November 18, 1883.

At first people were angry about the idea. Many felt that nature should determine time, not the railroad officials. But pretty soon they realized it was helpful to have standard time. Thirty-five years later, in 1918, Congress passed the Standard Time Act, making the time zones official in the United States.

Look at a map of the United States. Why do you think the time zone lines zigzag? (Imagine what would happen if a time zone line ran right through your town...or right through your house.)

EPISODE

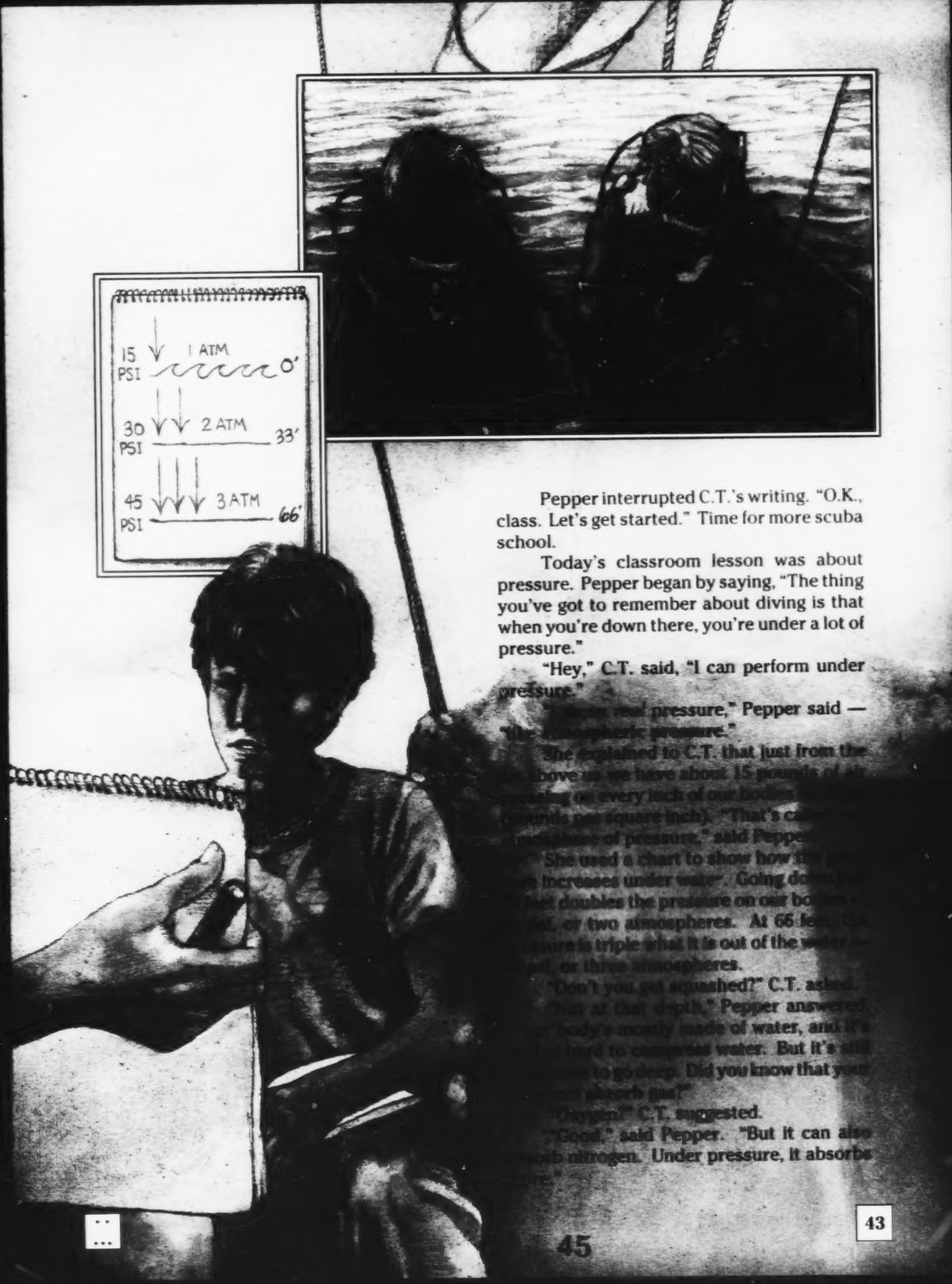
[illegible]

Pepper and C.T. plunged into the clear blue water and drifted slowly to the sandy bottom. C.T.'s scuba-diving lessons had begun. A T-shirt and blue jeans served as his wet suit.

Today, Pepper was teaching him how to get water out of his mask. To demonstrate, she pulled the mask away from her face to allow it to fill with water. Then she lifted the bottom part of the mask away from her face, tilted her head back, and breathed out through her nose. The air forced the water down and out of the mask. C.T. tried it, and it worked!

Back on deck, C.T. munched on chips from the souvenir Maya pot and wrote in his journal:

One day I'm just an ordinary swimmer and two days later I'm breathing underwater. It's really pretty easy. Well, I guess I was scared at first, but Pepper's a great teacher. It's great to breathe underwater, but it's nice to be able to see, too, especially since you have to use sign language to communicate. Diving's like being in another world. It's easy to forget it can be dangerous.



Pepper interrupted C.T.'s writing. "O.K., class. Let's get started." Time for more scuba school.

Today's classroom lesson was about pressure. Pepper began by saying, "The thing you've got to remember about diving is that when you're down there, you're under a lot of pressure."

"Hey," C.T. said, "I can perform under pressure."

"I mean real pressure," Pepper said — "the atmospheric pressure."

She explained to C.T. that just from the [illegible] above us we have about 15 pounds of air pressing on every inch of our bodies [illegible] (pounds per square inch). "That's called [illegible] atmosphere of pressure," said Pepper.

She used a chart to show how the pressure increases under water. Going down [illegible] feet doubles the pressure on our bodies — [illegible], or two atmospheres. At 66 feet, the pressure is triple what it is out of the water — [illegible] psi, or three atmospheres.

"Don't you get squashed?" C.T. asked.

"Not at that depth," Pepper answered. "[illegible] body's mostly made of water, and it's [illegible] hard to compress water. But it's still [illegible] to go deep. Did you know that your [illegible] absorb gas?"

"Oxygen?" C.T. suggested.

"Good," said Pepper. "But it can also absorb nitrogen. Under pressure, it absorbs [illegible]."

Air is mostly nitrogen, and scuba tanks are filled with air. If your body absorbs too much nitrogen while you're underwater and you come up too fast, the nitrogen bubbles out as the pressure decreases.

Pepper popped the cap off a bottle of soda to show what happens. The gas in the bottle spewed out.

"And it's bad when it bubbles out like that?" C.T. asked.

"Let's just say it can cause serious complications," Pepper answered. "Like death."

This is what's called the **bends**, Pepper explained. Although people don't die from the bends very often, it can cause serious damage to the body. That's why scuba divers have to be careful about how long they stay underwater and how fast they come up.

As they got ready for the next diving lesson, Pepper quizzed C.T. "Remember what you do while you're coming up?"

"You remember to always keep breathing," he answered.

"Why?" asked Pepper.

"Because if you hold your breath, your lungs can explode."

"Right again. Why?"

C.T. had learned his lessons well: "Because when you ascend, the air in your lungs **expands** when you come up to less pressure."

Pepper nodded. "*¡Perfecto!*"

In the underwater lesson that followed, C.T. learned how to handle emergencies. He pretended that his tank was out of air and he and Pepper practiced buddy breathing. Then they practiced an octopus ascent, with C.T. using Pepper's extra **regulator** as they swam to the surface.

Later that afternoon, Victor, Terry, Captain Granville and Quiché arrived. They had spent two days in Mérida on paperwork for their underwater archaeological work.

Terry and Victor were happy to see Pepper aboard. And C.T. was proud to tell Quiché that he was learning to scuba dive.

"You coming with us this afternoon, C.T.?" Victor asked.

C.T. looked to his teacher, Pepper.

"He sure is," Pepper answered.

"Great!" C.T. said.

As the divers got ready for their underwater work, Captain Granville and Terry talked about the mysterious light on the cliff. Terry

had drawn a sketch of the Captain's theory that the fire sighted through the temple marked an opening in the reef.

"We'll check it out," Victor said. "If there is a passage through the reef here, then you can get *Mimi* through it, and we'll know where to start our dig."

In a flurry of activity, Victor, Pepper and C.T. set off to search for the passage through the reef.

Being forty feet deep in the ocean near a coral reef was an unforgettable experience. C.T. didn't know where to look first, there were so many things to see. For starters, they swam right through a school of incredible bright blue fish. Then a speckled stingray scurried along the ocean bottom below them, before suddenly darting away. A few minutes later a moray eel rippled lazily by, looking like a giant brown velvet ribbon. Victor led the way as the divers searched for an opening in the massive coral reef.

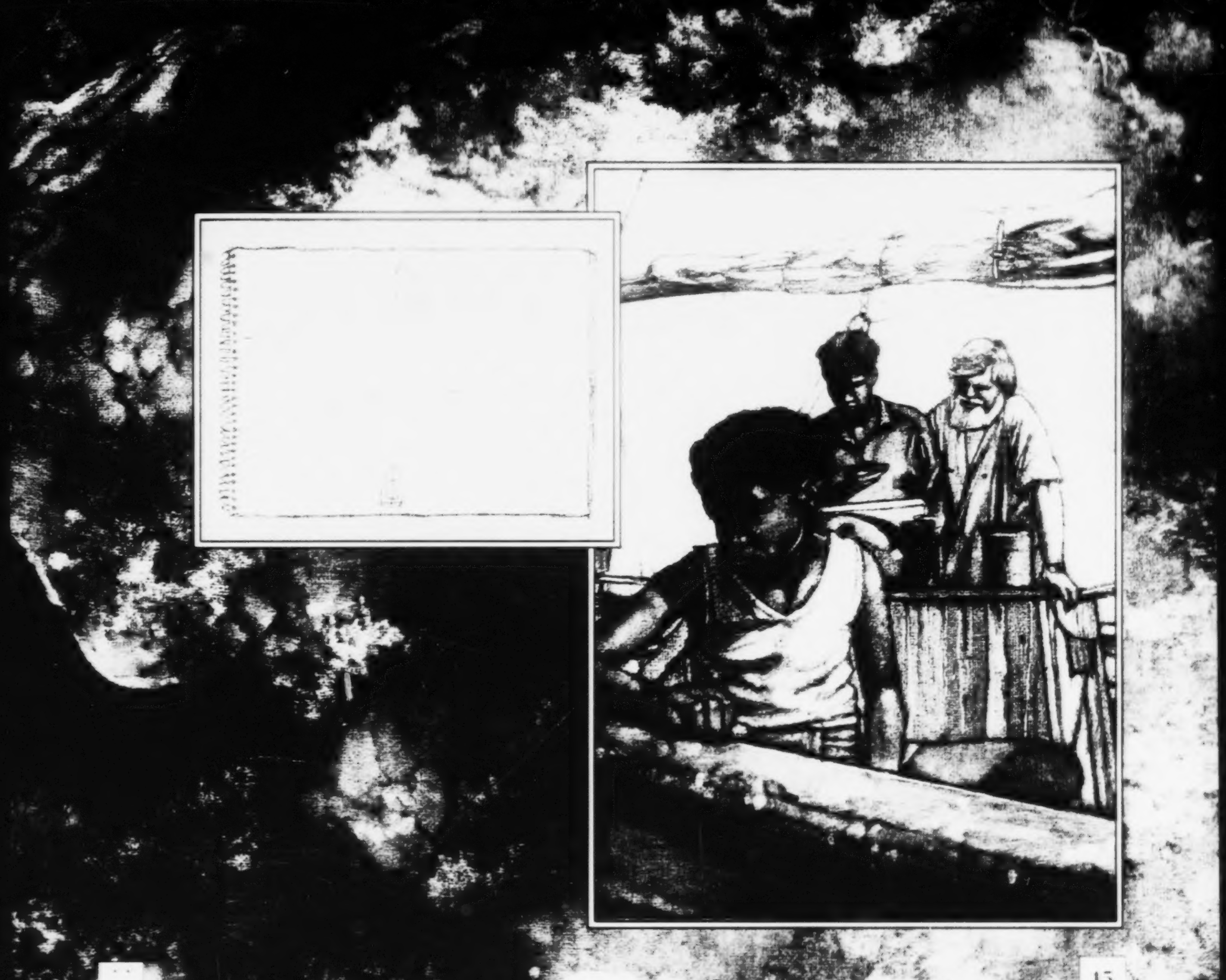
Back on *Mimi*, Quiché was feeling alone and left out. "Mom," she asked, "when can I learn to dive?"

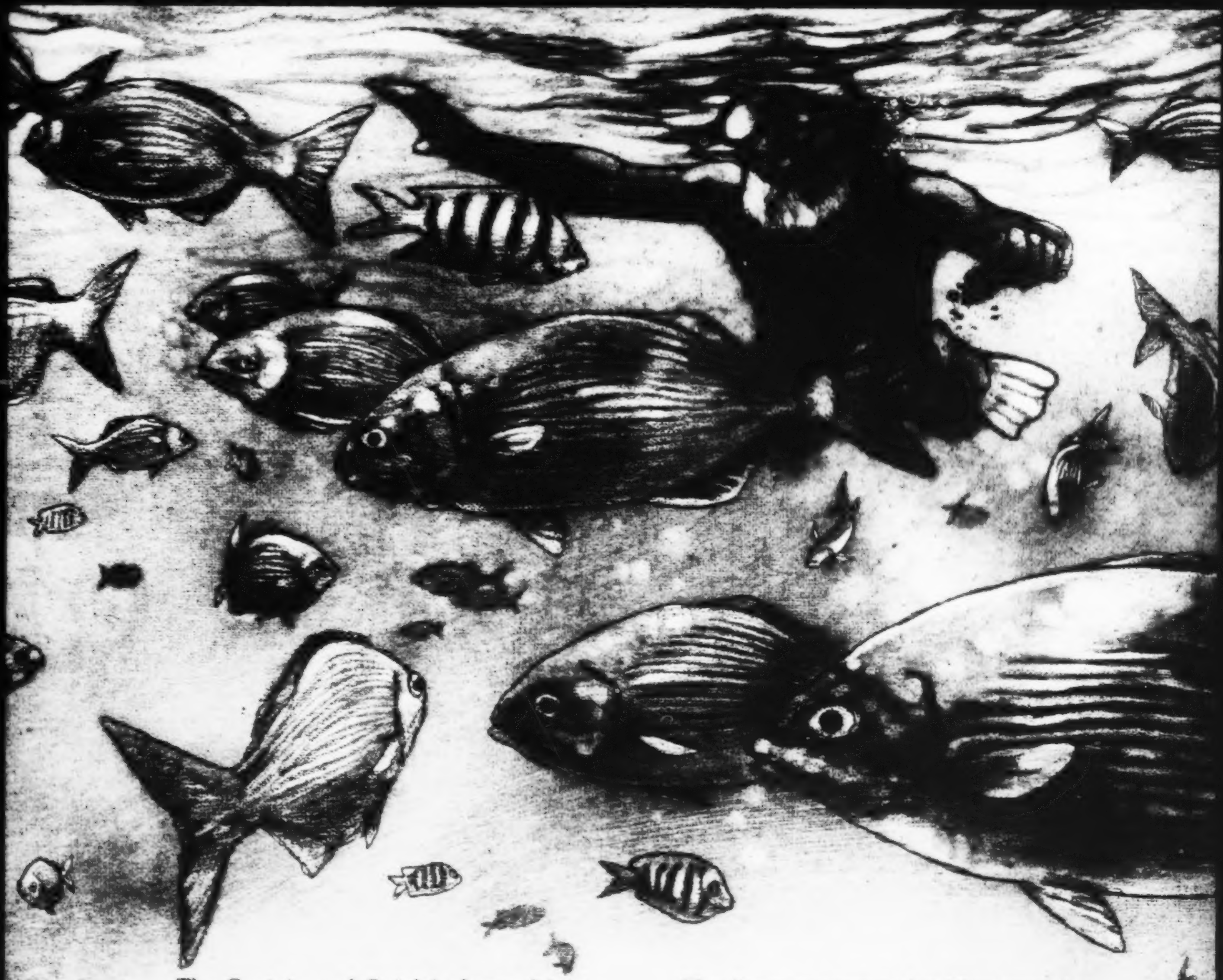
"Oh, a couple of years, kiddo," her mother answered.

That seemed like forever to Quiché. "Growing up sure takes a long time," she muttered sadly.

The Captain looked at her and smiled. "Better watch it, Quiché. I remember saying that. I think it was yesterday."

Then Captain Granville had an idea that might cheer Quiché up. "How'd you like to take a little cruise?" he asked her.





The Captain and Quiché changed into swimsuits, grabbed some **snorkeling** gear and climbed into the inflatable. Soon they were anchored in shallow water near the reef. "We don't have to go down forty feet in order to check out the bottom," Captain Granville said.

"Are we still lined up with the lighthouse and the reef?" Quiché asked.

"As far as I can tell," the Captain answered. "With the reef nearby, there should be all kinds of fish for us to feed."

He was right about that. Quiché and the Captain plunged into the water and were soon surrounded by schools of shimmering fish who ate bread crumbs from their hands.

Meanwhile, not far away, Victor, C.T. and Pepper continued to scout the reef. Victor was the first one to see the opening. Excitedly, he pointed it out to the others. "Plenty wide for Mimi" he wrote on his slate.

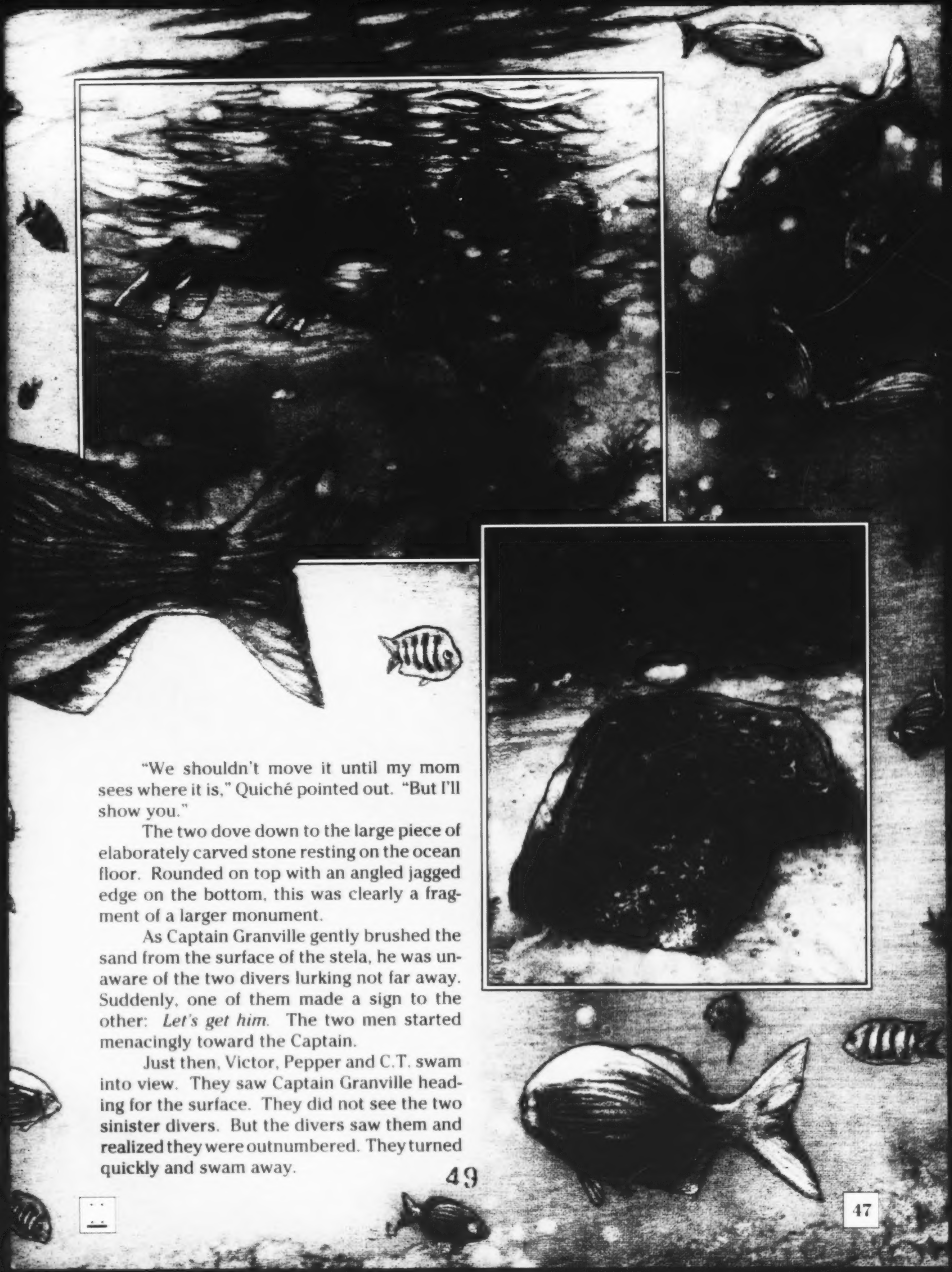
The discovery meant that *Mimi* would be able to pass through the reef and anchor in the calm waters near shore. And the archaeologists could begin to explore for evidence of ancient Maya traders.

After the fish food was gone, Quiché and Captain Granville swam about, investigating the sandy bottom near the reef. The Captain found a conch and held it up for Quiché to see.

Quiché skimmed along the surface, scanning the ocean floor for other interesting discoveries. Suddenly, she saw something strange lying in the sand on the bottom. When she went down to investigate, she could hardly believe what it was.

"Captain G., a **stela**!" she shouted excitedly when she got back to the surface. "A Maya monument! I can even read the date **glyphs**!"

"Let's get it!" Captain Granville said.



"We shouldn't move it until my mom sees where it is," Quiché pointed out. "But I'll show you."

The two dove down to the large piece of elaborately carved stone resting on the ocean floor. Rounded on top with an angled jagged edge on the bottom, this was clearly a fragment of a larger monument.

As Captain Granville gently brushed the sand from the surface of the stela, he was unaware of the two divers lurking not far away. Suddenly, one of them made a sign to the other: *Let's get him.* The two men started menacingly toward the Captain.

Just then, Victor, Pepper and C.T. swam into view. They saw Captain Granville heading for the surface. They did not see the two sinister divers. But the divers saw them and realized they were outnumbered. They turned quickly and swam away.

C.T. and the others couldn't wait to get back to *Mimi* to share news of their find with Terry.

"This is fantastic!" she said.

"I don't see how it could be in such good condition," said Victor.

Captain Granville had an idea. "That hurricane last month must have churned up the bottom and uncovered it."

"How are we going to get it up?" Quiché asked.

"We could use air," said the Captain. "We used to **salvage** gear from sunken ships that way."

Terry quickly got into scuba gear and joined the others in the salvage operation. Before they moved the stela, she carefully took photographs to document its location. C.T. and Quiché watched as the others tied heavy ropes around the stela. They put a plastic garbage bag inside a net bag and attached it to the ropes. Then, using air from the scuba tanks, they inflated the plastic bag.

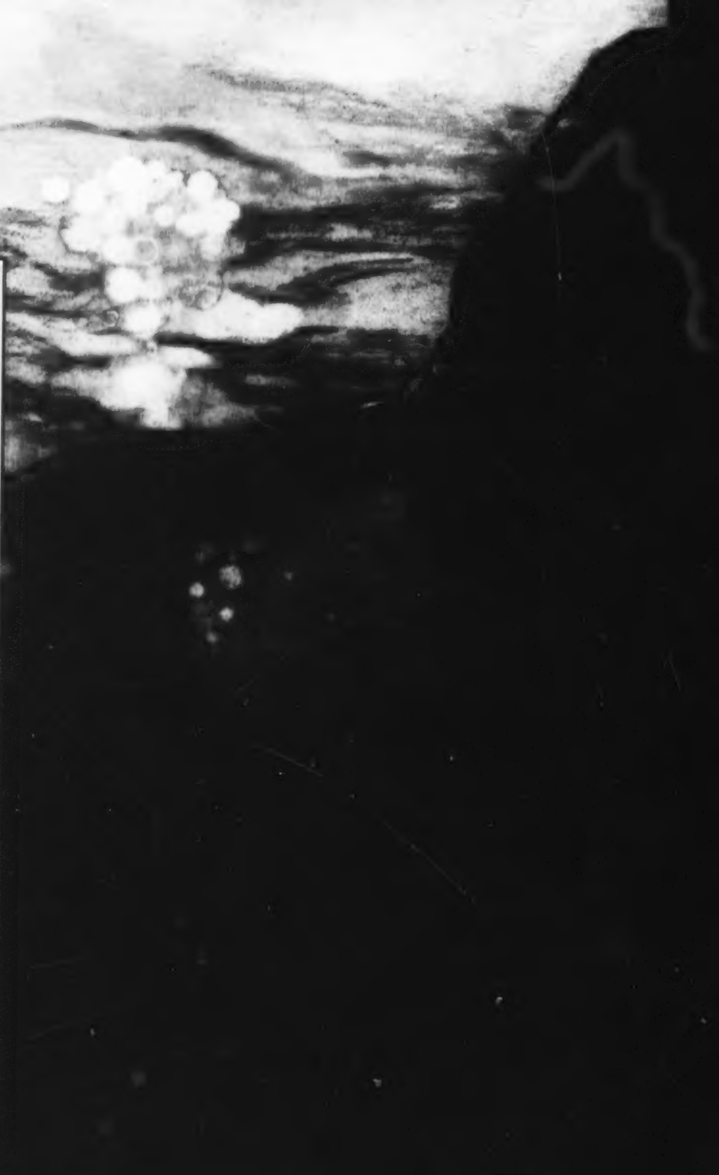
Slowly, the heavy stone monument began to move. As the air-filled bag rose toward the surface, the stela rose with it and hung suspended in the water. Captain Granville and the others pulled the stela to *Mimi*.

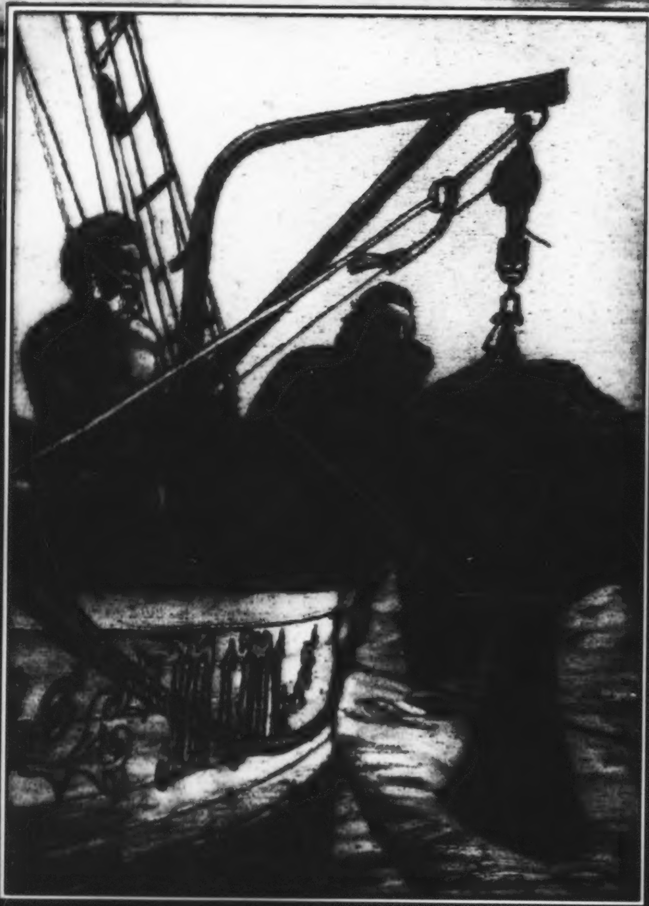
"I hope whatever's on this thing is worth reading," C.T. said as the stela was hoisted onto *Mimi*'s deck.

"Heavy reading, that's for sure!" Pepper quipped.

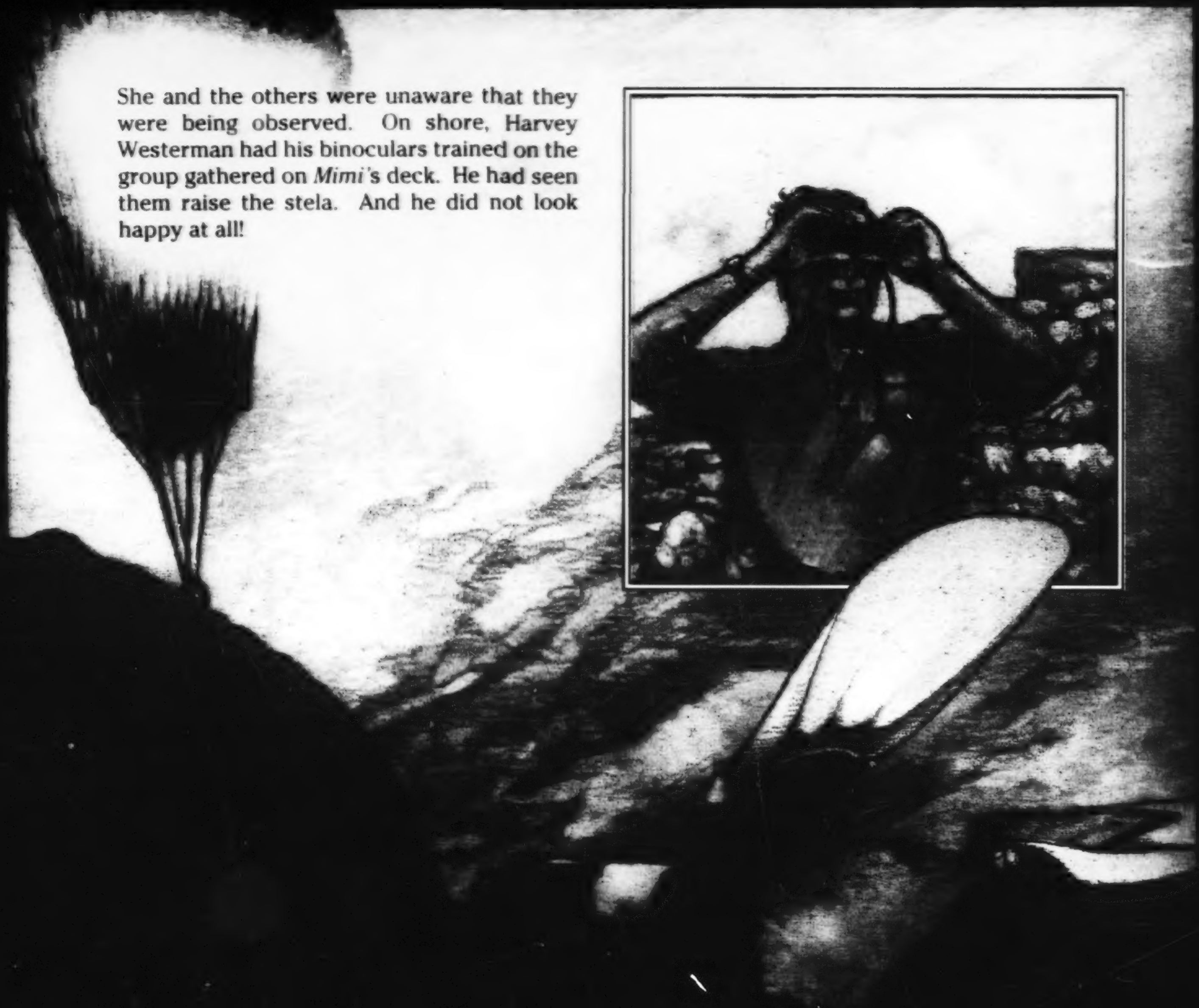
With the stela resting safely aboard *Mimi*, the excited group gathered around to admire their find.

"I can't wait to work on it," Terry said.





She and the others were unaware that they were being observed. On shore, Harvey Westerman had his binoculars trained on the group gathered on *Mimi*'s deck. He had seen them raise the stela. And he did not look happy at all!



-ACTIVITY-

PERFORMING UNDER PRESSURE

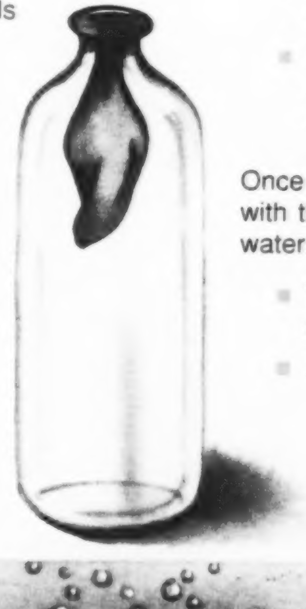
When Pepper gives C.T. his first scuba-diving lesson, she says,"One thing you've got to remember about diving is that when you're down there, you're under a lot of pressure."

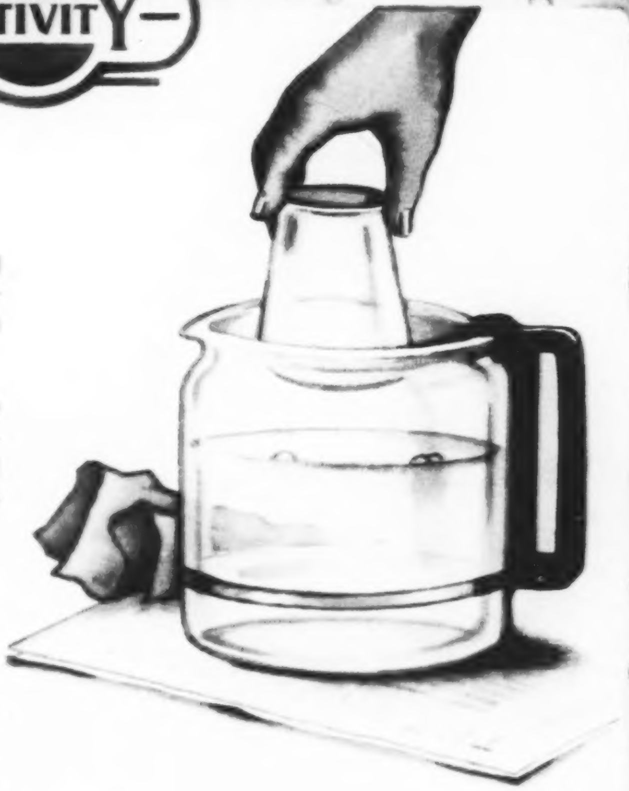
Air pressure is a powerful force we experience every day. Since it's invisible, it's hard to understand how it affects us. These experiments will give you a chance to experience and observe the power of air and water pressure.

You will need:

- an empty clear plastic bottle with a small mouth
- a deep clear container, like an aquarium or a clear tea kettle
- a clear plastic cup, small enough to fit easily into your container
- water (enough to fill the container two-thirds)
- balloons (small round ones are best)
- tissues
- empty milk or orange juice cartons
- a pan or sink
- newspaper, to absorb spills

1. Put an uninflated balloon inside an empty clear plastic soda bottle with the opening of the balloon around the bottle rim. Now try to blow the balloon up.
   - What happens?
   - What is your theory about why you can't blow the balloon up?





2. Fill an aquarium or other large, clear container two-thirds full of water. Hold a clear plastic cup upside down. Try to get it to the bottom of the tank of water without getting the inside of the cup wet.
   - How is it possible that the cup can stay dry inside?
   - If you stuff a tissue into the bottom of the cup and try it again, will the tissue stay dry?

Once you have the cup on the bottom of the tank with the inside dry, get the cup to fill up with water.

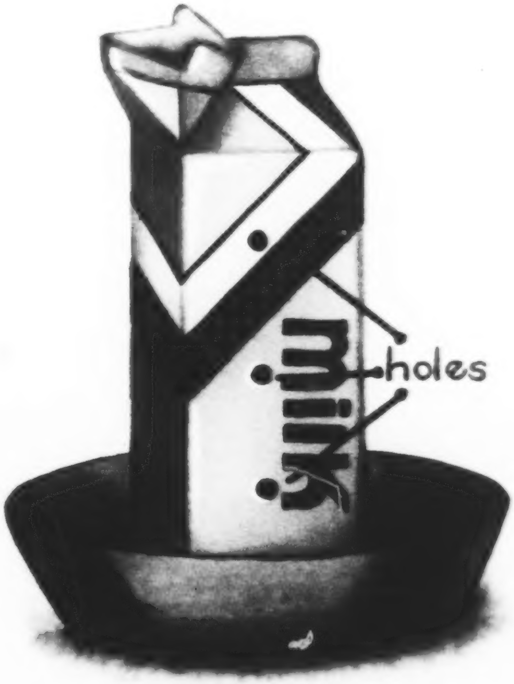
- What do you observe when the water starts going into the cup?
- What do you think is happening?

> "From this day forward we would swim across miles of country no one had known, free and level, with our flesh feeling what the fish scales knew."
>
> Jacques Cousteau, *The Silent World*

Inventors discovered this property of water and air and made diving bells which were big enough for people to stand inside. If held level, the bells would retain a pocket of air so the people could breathe. They could then swim out, explore around a little and return to the bell for more air.

3. Take an empty carton and use your pencil to punch three holes in a line going up one side of the carton. Predict what will happen if you fill the carton with water.
   - Will the water come out?
   - Will one of the holes shoot the water out in a longer stream? Predict which one might.

If you have a few cartons try different arrangements of holes and see what results you get.



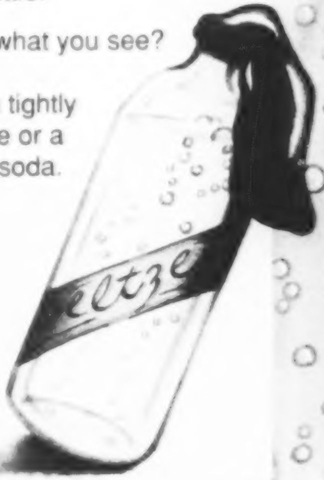
HERE COMES THE FIZZ

What causes the fizz when you open a bottle of soda? Why does soda get "flat"? What has that got to do with divers getting the bends? These experiments may give you some clues.

You will need:

- an unopened clear bottle of soda (such as seltzer or club soda)
- a clear plastic cup
- a small balloon

1. Look carefully at the sealed bottle of soda.
   - Do you see any bubbles?
2. Watch carefully and open the bottle.
   - Are there more or fewer bubbles now?
   - Where do you think the extra bubbles came from?
3. Pour some soda into a clear cup. Tightly cover the soda bottle.
   - What do you think will happen to the soda in the cup in a few hours?
   - What about the soda in the bottle?
4. To test your theory, open the bottle later and compare the number of bubbles in the cup to the number in the bottle.
   - What might explain what you see?
5. To find out, fit a balloon tightly over the top of the same or a newly opened bottle of soda. Leave it for an hour.
   - What might happen? Check and see.
   - Can you think of a theory to explain what happened?



EXPEDITION

When Ben Affleck learned to scuba dive for "The Second Voyage of the *Mimi*," he learned a lot about pressure and how it affects you. It also made him wonder about some things. He went to the North American Hyperbaric Center in City Island, New York City, to find out more about pressure. "Hyperbaric" means high pressure. The people who work at the Hyperbaric Center should be experts on the subject. They've promised to put Ben into one of their high pressure chambers. But first he'll get a lesson on what pressure is all about.

Glenn Butler is one of the diving experts at the Center. He started out by showing Ben a small hyperbaric chamber. It can be pressurized to the equivalent of ten atmospheres—ten times atmospheric pressure.

"Ten atmospheres? How do you get that much?" Ben asked.

"We have air cylinders outside that push air into this chamber. Because the volume is fixed, as we push air into the chamber, the pressure goes up," Glenn said.

The chamber is made of steel, and can't expand. So as more air is pushed into the chamber, the air becomes more dense and exerts more pressure. The chamber has to be thick to withstand ten atmospheres of pressure. In fact, the walls of this chamber are over four inches thick in spots.

We're under the weight of the atmosphere, about 100 miles of air, all the time. That produces 14.7 pounds of pressure on each square inch of our bodies. That pressure, 14.7 pounds per square inch, is called one atmosphere of pressure. Water is a lot heavier than air. It takes only 33 feet of water to produce the same pressure as 100 miles of air.

Glenn Butler explained to Ben Affleck that the small hyperbaric chamber can be pressurized to the equivalent of ten times normal atmospheric pressure. "Hyperbaric" means "high pressure."

As the gauge showed the increasing pressure, Ben looked through the small window to see the effects on the objects inside.

Ben brought a bunch of different things to put into the chamber. He wanted to see what pressure did to them before finding out what it would do to him.

He started with a basketball. A basketball is hard because of air pressure inside the ball. It has about seven pounds per square inch (psi) *more* than atmospheric pressure. Ben pressed on the ball with all his strength and couldn't squeeze it much. It was hard to imagine how just air pressure could.

Ben closed the door to the hyperbaric chamber. He had to use his whole body to move it.

"This door has to hold back 46 tons," Glenn said. He explained that 130 psi at 10 atmospheres over the whole door area, which is 2 1/2 feet in diameter, adds up to 46 tons.

They stepped around to the controls. The pressure gauge is calibrated from 0 to 700 feet. The Hyperbaric Center is a dive school, so pressure is measured in feet of sea water, to simulate being under water. The chambers are actually dry and the pressure is produced by air. Ben's experiments would be conducted between 0 and 300 feet, or a maximum of 10 atmospheres.

Ben looked through a small window in the chamber as Glenn opened a valve. With a hiss, air from the tanks outside began rushing into the chamber. At 10 feet of pressure, a small dent appeared in the basketball. At 20 feet, the ball began to cave in. At 33 feet, twice normal atmospheric pressure, the ball looked as if a giant had stepped on it. It was about half its original volume.

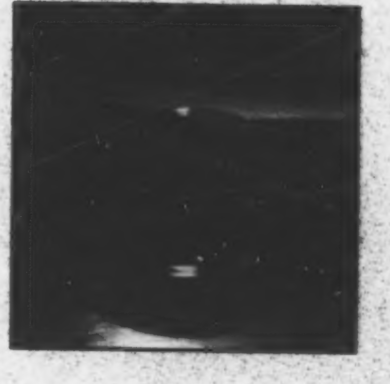
Glenn read "depth" off the gauge as Ben watched the basketball collapse. At 66 feet or 3 atmospheres—triple normal atmospheric pressure—the air in the ball was one-third its original volume. At 4 atmospheres, the volume was one-fourth, and so on.

When the pressure in the chamber was at 6 atmospheres, 6 times normal atmospheric pressure, Ben asked, "We haven't let air out of the ball, have we?"

Glenn replied: "The same amount of air is in there, but we've squeezed it. Using outside pressure on the ball, we've squeezed the air on the inside of the ball much smaller."

At 10 atmospheres, the ball looked almost flat. Glenn started to depressurize the chamber. He turned a valve that let air back out. The ball began to inflate again. At 33 feet of depth, or twice atmospheric pressure, it looked half full. Between 33 feet and the "surface," the volume of air inside the ball doubled in size until it was perfectly inflated again.

At 1 atmosphere, the fully inflated basketball is hard and round.



The same basketball, the same amount of air, at 10 atmospheres.

When they took the basketball out, back into 1 atmosphere or 14.7 pounds per square inch pressure, it was back to normal. Ben bounced it a few times to make sure.

"If you were in there at 130 pounds, would you feel pressure on you?" Ben wanted to know.

A person wouldn't be squashed as the basketball was because a person is mostly liquid. Liquids are not compressible. That's one of the great differences between liquids and gases. Gases can be compressed. You have air spaces in your lungs and ears, but your body is basically a liquid and it's not compressible. That's why people can go underwater.

Glenn suggested they try an experiment to compare water and gas. He filled a blue balloon with water and a yellow balloon with air until they were the same size.

As the chamber was pressurized, Ben predicted that the blue balloon wouldn't shrink. At 2 atmospheres, or 33 feet, the yellow balloon was about half the size of the blue one. Glenn pointed out a small air bubble in the water-filled blue balloon. The air bubble was actually getting smaller as the pressure increased.

"At a really low depth, the air bubble will disappear," said Glenn. "It will actually be absorbed into the water."

Gases can be absorbed in liquids. The more pressure is applied, the more gas is absorbed. That's how nitrogen gets in a diver's blood, sometimes causing the bends. Glenn added that soda is **carbonated** by pushing gas, usually carbon dioxide, into the liquid under pressure.

They continued adding pressure up to 230 feet of sea water. The yellow balloon got smaller and smaller while the blue balloon remained the same size. Ben wondered whether the pressure inside the water balloon was the same as the air pressure. Glenn said that it was.

Ben asked about the effect of scuba diving on his body. Would the pressure inside and outside his body be the same?

"Yes," Glenn answered. "At any given depth in the ocean, the water pressure is exerted all over the body and transmitted through the body."

As they depressurized the chamber, the balloon filled with air returned to its original size, doubling in the last 33 feet. Ben was reassured. His body, being mostly water, would survive the hyperbaric chamber. However, the next experiments got him worried again.

Two differently-shaped light bulbs, an egg, and an empty gas can were put in the chamber. The gas can developed a leak, so it never completely collapsed. Nothing happened to

At 1 atmosphere, the air-filled yellow balloon and water-filled blue balloon are the same size.

Under pressure, the air in the yellow balloon was compressed. Water is not compressible, so the blue balloon did not shrink.

the other objects until they reached 300 feet of sea water or over 130 pounds of pressure per square inch. Suddenly one of the light bulbs burst with a loud bang.

"Whoa! It exploded!" exclaimed Ben.

"It **imploded**, it didn't explode," Glenn corrected him. "The gas pressure outside the bulb was so great that the bulb actually collapsed or imploded."

Glenn explained why the egg and the other bulb survived the pressure. First, a raw egg is filled with liquid. Plus, gases like air can pass through the shell (which is one reason a chick can live in there). The egg also has a shape that can withstand a lot of pressure. The best shape for that is a perfect **sphere**.

The second light bulb was a small, round one. "This is closer to a sphere," Glenn said. "Another reason it's so strong is that the force is divided equally over it." The other bulb had collapsed because it had a long, narrow shank that could get pushed on.

Next Ben and Glenn tried another can and a rigid plastic container. As they pressurized the chamber, Ben was surprised. The can soon looked like it had been punched. It finally folded in half and tipped over. But the plastic container just sat there.

"Believe it or not," Glenn said, "the plastic is more rigid than the steel in the can. Watch carefully now." All of a sudden the plastic container burst, splintering all over the chamber.

Ben was already worried about going into the big hyperbaric chamber. The final experiment made him feel worse.

Glenn had two styrofoam heads. He put one in the chamber and kept one outside for comparison. Styrofoam is made of thousands of little plastic bubbles filled with air. As the chamber was pressurized, the head inside began to shrink. It got smaller and smaller.

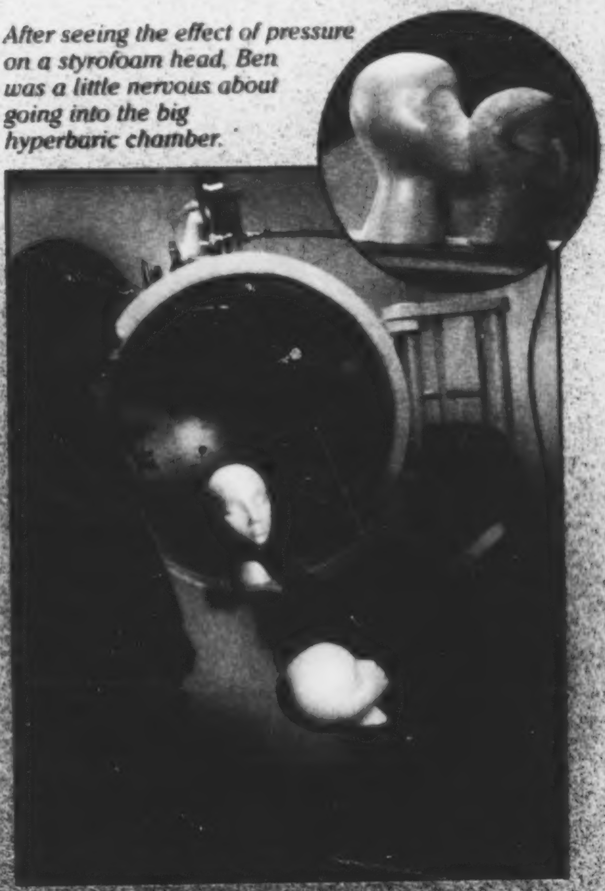
"Do you think this is going to happen to my head?" Ben asked with some trepidation.

"Not unless your head is filled with styrofoam," replied Glenn.

Some of the tiny air bubbles in the styrofoam must have burst, because the head never did come back to its normal size, even after they took the pressure off.

Now it was Ben's turn. He knew he'd be O.K., but he would be under the pressure of a 100-foot dive—4 atmospheres of pressure. And he just couldn't forget that styrofoam head.

(to be continued)



After seeing the effect of pressure on a styrofoam head, Ben was a little nervous about going into the big hyperbaric chamber.

A WORD WITH MANY MEANINGS

What word is missing in these sentences?

1. "Air ___________ inside the basketball makes it hold its shape no matter how hard you push on it," said the coach.
2. "I'm not sure I'm ready for this kind of ___________," said the diver, as she prepared to go 500 feet under water to test some new equipment.
3. "A high ___________ system is moving in from Canada," said the weather forecaster. "Sunny skies tomorrow."
4. The ___________ is on when you have a science project due on Tuesday and by Monday night you haven't begun it yet.
5. "Does it hurt when I put ___________ here?" asked the doctor, as she pushed on my aching swollen glands. "Ouch!" I replied.

Pressure literally means, "the state of being acted upon by a steadily applied force or weight."

EPISODE

The stela sat safely on deck, drying in the hot sun. The *Mimi* crew stared at it in awe, admiring the delicate carvings that covered the surface of the stone slab. Strange hieroglyphics. The profile of a powerful man wearing a ceremonial headdress. To C.T. it seemed as if they'd suddenly taken on a new passenger, a traveler from the past who spoke a language he'd never heard before.

"It's from Cobá," Quiché announced, pointing at a glyph. "This is the **emblem glyph** for Cobá." C.T. remembered that Quiché could understand this foreign tongue, at least some of it. He was impressed.

Terry explained that every big Maya city had its own hieroglyphic signature, like a coat of arms. This was definitely Cobá's emblem glyph, but that didn't necessarily mean the stela was *from* Cobá; whatever was written on it might be *about* Cobá. How it ended up in the waters off Tulúm was a mystery.

Victor said that stelas were usually records of major events in the lives of rulers.

"Think we'll find the other half?" Quiché said. It was frustrating not to have all the pieces of this stone puzzle.

"I sure hope so," her mother answered. "It'd be nice to know who this fancy fellow is."

Captain Granville decided it was time to try to navigate *Mimi* through the opening in the reef. "I'd better give Granny a hand," Pepper said, following him.

There was a moment's silence. Then, "Did she say *Granny*?" Terry asked in disbelief. C.T. turned away, trying to hide his smile.

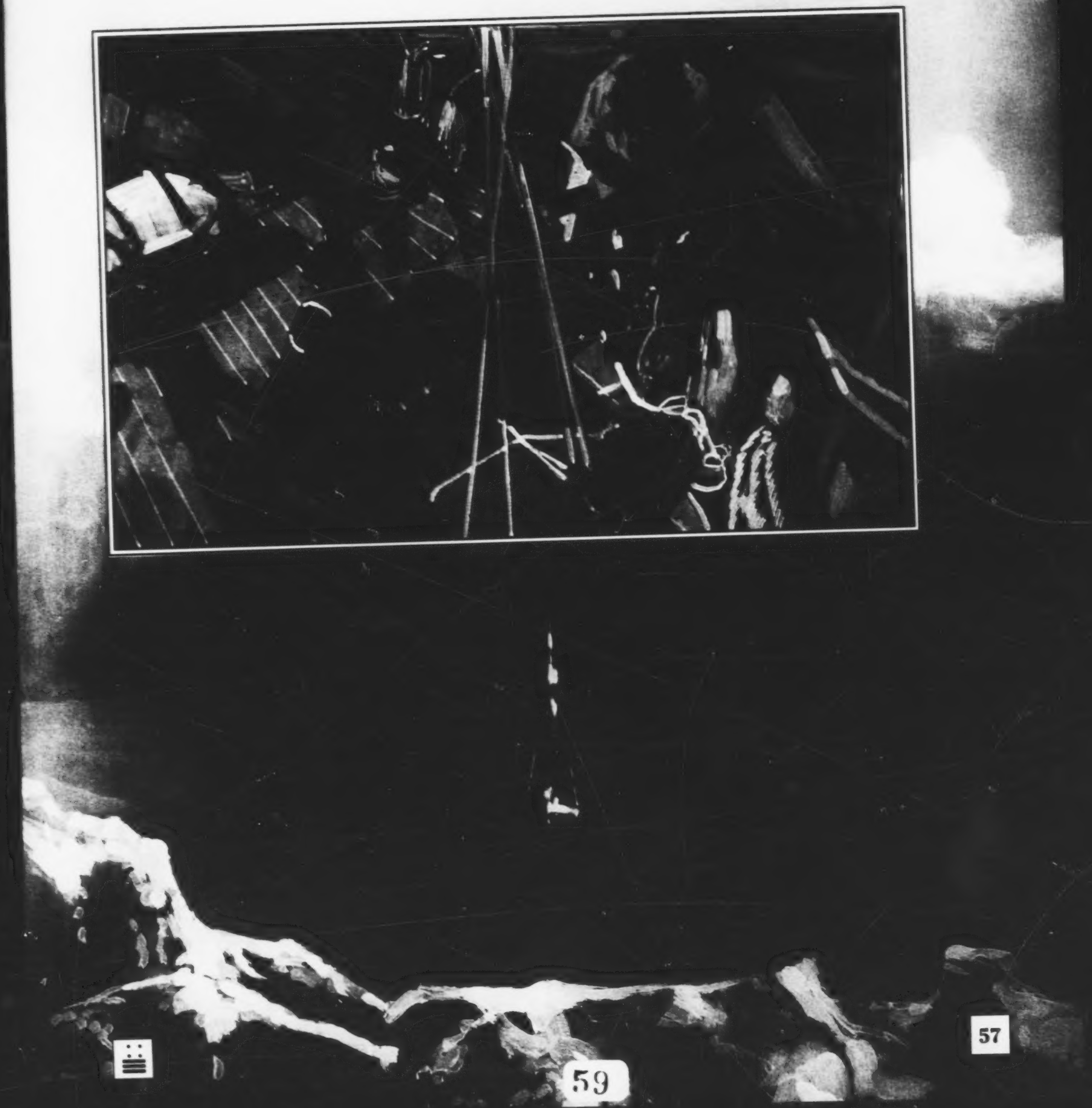
The Captain and Pepper guided *Mimi* into the calm waters inside the reef. Meanwhile, high up on the cliff, Harvey Westerman observed their progress, scowling. He didn't like it when people got in his way. Something would have to be done.

By late afternoon Quiché and her mother had deciphered enough of the hieroglyphics to know that the stela referred to a ruler of Cobá: Chac Balam. His name meant "Strong Jaguar." Or "Red Jaguar," Quiché said. *Chac* meant "red" as well as "strong."

They'd seen his glyph on other monuments at Cobá. He was famous because he had disappeared. There was no record of him after age thirty, no record of his death. Very peculiar for a Maya king. His story was one of the big mysteries of Maya archaeology.

"And the answer might be right here," Quiché added, gazing down at the stony face.

Victor suggested that they go to Cobá to see if they could find any more clues.



Villas Arqueologicas
HOTELES
COBA
RUINAS

They piled into the jeep early the next morning. Chac Balam's stela lay at C.T.'s feet, wrapped in a blanket. Pepper stayed behind to babysit *Mimi*. She'd invited Segovia for a Texas-style meal. And she'd have a chance to fix the starter motor. She was getting tired of having to start the engine by climbing down into the engine room and thwacking the starter motor with a screwdriver as Granny turned the ignition key above.

Cobá lay about fifty kilometers inland. The road was straight as a ruler. It was as if somebody had taken a giant lawn mower and cut a line through the jungle. The thick vegetation grew right to the edge of the road.

C.T. sat in back with Victor. He showed him a piece of black glass he'd picked up in Tulúm. "That's obsidian," Victor said, explaining that it was a form of natural glass made in volcanoes. The ancient Maya had no metal, so they used obsidian for their knives and tools. "This is part of a Maya knife," Victor concluded.

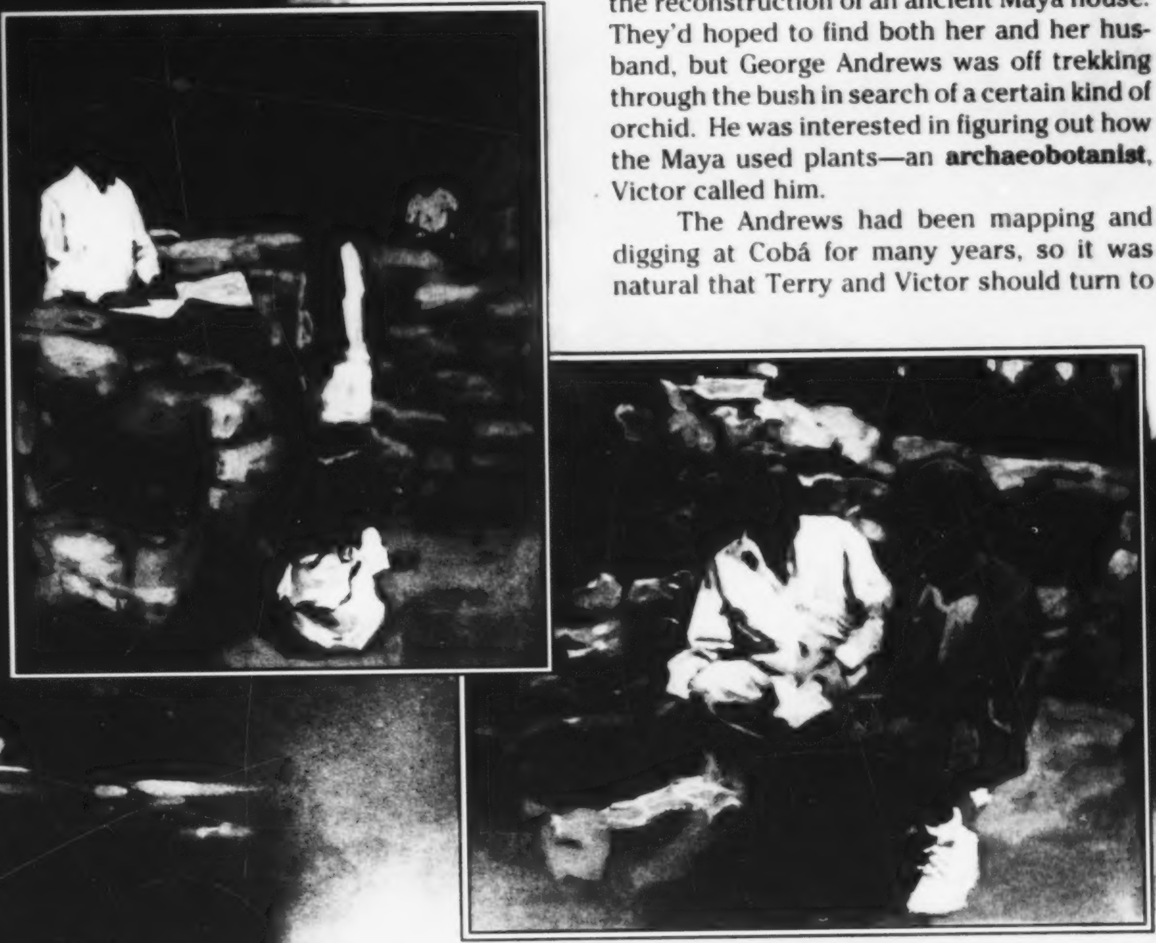
C.T. looked dismayed. "Oh no," he said. "I'm a looter! I took something from an archaeological site."

"It's O.K., *amigo.* Just take it to Segovia tomorrow and show him where you found it." Victor paused. "You are young; they will probably only give you a few months in jail."

C.T. laughed at his joke, but Victor only stared at him, suddenly somber. Was he serious? Jail? C.T.'s face fell. *Yikes!*

Victor laughed. He *was* joking. But he'd made his point. Looting was no joke.

Cobá wasn't like Tulúm. It was a wild place in the middle of the jungle, alive with birdsong. The main pyramid towered above the flat landscape like a mountain.



They found Jean Andrews supervising the reconstruction of an ancient Maya house. They'd hoped to find both her and her husband, but George Andrews was off trekking through the bush in search of a certain kind of orchid. He was interested in figuring out how the Maya used plants—an **archaeobotanist**, Victor called him.

The Andrews had been mapping and digging at Cobá for many years, so it was natural that Terry and Victor should turn to them for help in unraveling the mystery of Chac Balam.

Jean brought them up to date on her work. She was working with a crew of Maya masons to rebuild some of the buildings they had excavated. "They've developed a real feel for how their ancestors built," Victor said, as they watched a couple of the men cement a time-worn stone into a wall.

The site was turning out to look pretty much the way Terry had pictured it in her drawings, Jean said. To C.T., it just looked like a bunch of rough low walls.

Jean explained that they put back together only the pieces they were sure about. The site wouldn't look like it did in ancient times unless they could find all the pieces and knew exactly how they fit together.

"How do you know this was a house?" C.T. asked. "Could it have been, say, a store?"

Jean showed him around the site, pointing out various pieces of evidence: a large **mortar**, called a *pila*, and **pestle**, called a *mano*, for grinding corn; pot **sherds** from plain pots; and a **midden**, or garbage dump, containing the remains of household items.

"Yeah, but why does this house look so different from the ones they build now?" C.T. asked, thinking of the thatched huts he'd noticed in the Maya villages.

"Excellent question," Jean said. "Excellent. Wood and thatch don't stick around for a thousand years," she explained. "They rot. So we're left with stone buildings, the kind richer folk lived in. Now what do you think?"

C.T. paused. "*Could've* been a house," he answered, carefully.

"I like the boy!" Jean announced.

Jean was impressed by their stela, when they finally got around to showing it to her. She studied it intently, then surprised them all by saying she thought she had the other half.

"You do?" they said in unison.

Indeed she did. The two halves fit snugly together like pieces of a giant jigsaw puzzle. They couldn't believe it. Jean and George had just uncovered their half the week before.

"How could one half of a five hundred-pound stela get from here to Tulúm?" C.T. wondered.

Victor was sure this was the work of looters. Terry agreed. She said monuments like this were very rare and valuable. Looters sold them to rich collectors all over the world. Sometimes they even cut them up with chainsaws and sold the pieces.

Quiché had been studying the glyphs in silence. She had noticed the glyph for "captive" next to the one that identified Chac Balam. "Maybe he was captured," she said.

Now everybody stared at the carved markings, excited by her discovery. "Does it say where they took him?" C.T. asked.

Quiché pointed to a glyph. It was right on the crack that divided the two halves of the stone, so she hadn't been able to read it before. "Isn't this an emblem glyph?"

Terry leaned in to examine it. "It sure as heck is," she said, her excitement growing. She looked at Victor and smiled. "Site U?" she asked, already sure of the answer.

"Yes," Victor said, triumphantly. He turned to the others. "Site U is a lost city. U stands for 'undiscovered' or 'unknown' or–"

"Or 'unbelievable,'" Terry laughed. "We're not even sure if it really exists."

"This emblem glyph has turned up before," Victor said, "but so far...*¿quién sabe?*"

Granny was thinking aloud. The piece they found underwater must have been stolen from Cobá and taken to Tulúm by the looters. That much was clear. Which meant that...

"[illegible] Pepper's all right!" C.T. interrupted.

"Oh [illegible]," [illegible] "Segovia's the one we should worry about. He's eating Pepper's chili."

Segovia *was* eating Pepper's chili and loving it. "You've got the toughest tongue this side of the Rio Grande," she said.

After dinner, they talked while Pepper worked on the starter motor, which lay in pieces on the table. Suddenly, Pepper froze.

"*¿Qué pasa?*" Segovia asked.

Pepper sensed that something was wrong, but she wasn't sure what. She leapt up from her seat, worried, and rushed up on deck. The sound of waves crashing against rocks greeted her.

"The anchor's not holding!" she told Segovia when she got below. "We're going to be on the rocks unless we..." She reached up and turned the ignition key. Nothing happened. She tried it again. Again nothing happened. Then she remembered why.

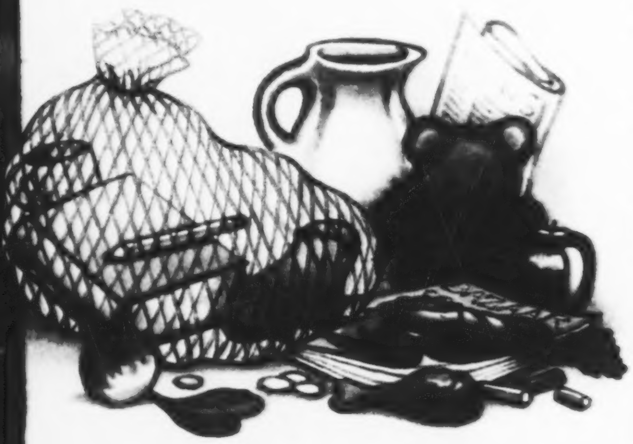
"Oh no!" she said, looking down at the pieces of the starter motor scattered all around. The waves crashed again, even louder than before.

-ACTIVITY-

DIG THIS

When archaeologists find ancient **artifacts**, they find only part of the story. Most things are transformed by time. Some things disappear entirely. Other things seem to last forever, with very little change. Can you predict what kinds of things would last, what kinds of things would be changed and what kinds of things would **decompose** and disappear? Here's an experiment to help you find out.

Choose some objects you use in daily life. Include things that you think will be transformed by time and things you think will stay the same. Some suggestions are: food, a newspaper, a book, a magazine, pencils, pens, nails (not **galvanized**), chalk, artwork you've done, coins, cloth, something plastic, something glass, something metal, a piece of chicken with a bone, ceramics, carved wood.



Bury them in the ground outside, or bury them in a jar or aquarium that you can keep inside.

If you bury your artifacts outside: Make sure you have permission to dig in the spot you've chosen. Mark the spot clearly and make a map so you can find your artifacts to dig them up later. Bury them in a plastic net bag or other container that won't decompose and will allow the artifacts to be exposed to the soil.

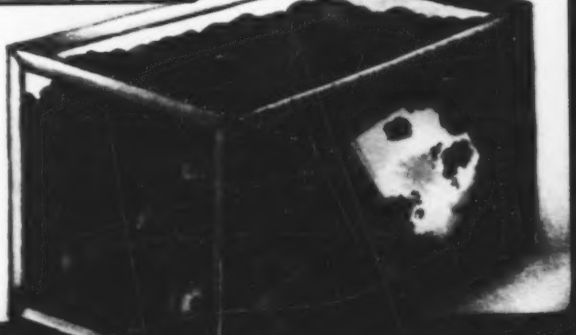
If you bury your artifacts inside: Be sure to use soil from outdoors, not packaged potting soil. Soil from outside will have lots of microbes and insects which help decomposition happen faster. Bury some artifacts near the sides, so you can see changes that are taking place. Sprinkle some water on the tank once a week. That will also help decomposition.

Make a schedule for when to dig your artifacts up. You'll probably want to check them a few times—perhaps after a few weeks and then after a few months.

Predict what you think will happen to each artifact. Make a chart or keep notes of your predictions and observations.

Here's another idea: Make duplicate sets of artifacts. Bury one set inside and one set outside and compare what happens. See which set decomposes faster.

Object	What will happen? Prediction	How it looks after 2 weeks	How it looks after 6 weeks	How it looks after 12 weeks



Ben Affleck's visit to the North American Hyperbaric Center included a simulated "dive" to a depth of 100 feet in a large hyperbaric chamber.

Ben Affleck was learning a lot about pressure during his visit to the North American Hyperbaric Center at City Island, New York. Now he was about to go into a hyperbaric chamber himself. He was a little worried. Experiments in the small hyperbaric chamber showed him how air pressure could crush a basketball, make a light bulb implode, and shrink a styrofoam head.

Jim Tyrrell would control Ben's simulated dive. The control panel looked like something out of a submarine. The pressure would be measured in depth of sea water, as if Ben were actually diving in the sea. Jack Leibolt would control the "depth" by opening valves to push air into the chamber and increase the pressure. If anything went wrong, he could bring Ben "up" by letting air out. Dr. Rolando Sanchez would accompany Ben on the "dive."

The big hyperbaric chambers are used to train divers, but they can also save divers' lives. The chambers are used to treat scuba divers who have the bends or decompression sickness. Ben knew that the bends occurred when a bubble formed in a diver's blood.

"What we do is take them to the chamber and recompress that bubble and get it to reabsorb," said Dr. Sanchez.

"What's going to happen to me down there?" Ben asked.

Dr. Sanchez explained that the first thing Ben would feel would be pressure in his ear. The eardrum is a thin piece of specialized skin that stretches across the passage leading from

Dr. Rolando Sanchez and Ben enter the chamber to begin their "dive."

the middle ear to the **Eustachian tube**. The Eustachian tube connects to the back of the throat.

If the external pressure increases, and you don't equalize the pressure in all the ear passages, the air can be forced in on the eardrum and could puncture it. When you close your nose and blow, that opens the Eustachian tube and forces air into the middle ear, equalizing the pressure.

"That's why it's important, when you're flying or scuba diving, to maintain equal pressure—to clear your ears," said Dr. Sanchez.

"You guys ready to go diving?" asked Jim.

Ben and Dr. Sanchez climbed into the chamber. Ben had some experiments to set up. Some were to measure pressure and others were to show the effects of it. He brought two different homemade **barometers** to measure air pressure.

One barometer was made by stretching a balloon over an open jar. Ben had devised a stand made out of wire to hold a chopstick over the top of the jar so it could rest on the top of the balloon. As the air pressure increased, the balloon would be pushed down into the jar and the chopstick would go down as well. Ben could mark the change with a pencil line on the chopstick.

The other homemade barometer was just a piece of plastic tubing with some colored water in it. With one end clamped off and the other open to the rising pressure, the water should get pushed toward the closed end. Ben brought a journal to record information during the dive.

At normal atmospheric pressure, a hard-boiled egg will not fit through the opening of the bottle.

Only a slight increase in air pressure pushes the egg into the bottle. Ben had set up a number of other experiments to test the effects of increased pressure.

On the way "up," fog formed!

Before they began, Ben marked the level of the water and the level of the chopstick on his barometers. He labeled them "0 ft., one atmosphere." Outside the chamber, Jack and Jim began the countdown. Dr. Sanchez reminded Ben to clear his ears.

"Four, three, two, one..." The air rushed in with a loud groan. Ben felt the pressure on his eardrums right away. He had to keep clearing his ears to keep them from hurting.

Ben's first experiment was a success. He had peeled a hard-boiled egg and set it in the mouth of a bottle. The bottle opening was smaller than the egg, but it didn't take much of an increase in air pressure to push the egg into the bottle.

At 10 feet they stopped to make sure everything was O.K. It felt funny to Ben, having to constantly clear his ears when he wasn't really going anyplace.

"Look at my barometer!" he exclaimed. The balloon was bulging down into the jar. Ben made a new mark on the chopstick. He checked the other barometer. The air pressure had already pushed the liquid up the closed side of the tube. Ben marked the new water level and labeled it, "10 ft."

As the air pressure increased, Ben had to clear his ears often to keep them from hurting.

They continued to 33 feet—one added atmosphere of pressure. Now they were under two atmospheres of pressure. Ben had to keep clearing his ears. The chamber was warmer. The thermometer read 81 degrees Fahrenheit. As the pressure increased, the temperature rose.

Ben's voice sounded higher and nasal, a little like a cartoon character. Dr. Sanchez said it was partly because the air was more dense and partly because the pressure changes the shape of some parts of the throat.

The balloon in one barometer filled half the jar as if someone were blowing it up. The water level in the tube barometer had moved several inches.

As they "traveled" Ben noticed what was happening to the other objects he had brought with him. A gasoline can had caved in. Balloons were half their original size. He was glad his body was mostly water and couldn't collapse the way the basketball had.

At 3 atmospheres, the equivalent of being 66 feet under water, Ben was beginning to feel lightheaded. Their voices were even weirder.

"At deep depths you do sometimes feel a little funny," Dr. Sanchez said, "because you're absorbing an inordinate amount of oxygen..."

BANG! He was interrupted as the balloon barometer burst. Ben marked 66 feet on the other barometer. He noticed that the barometer was changing less with each added atmosphere of pressure.

They went to 100 feet, just over 4 atmospheres—deeper than Ben had ever been in water. The temperature was 92 degrees. So much air was squeezed into the chamber that it actually felt thick when Ben waved his hand.

Ben shook up a bottle of carbonated water and opened it. The soda didn't bubble out. The pressure in the chamber kept the carbon dioxide dissolved in the water.

Ben had what divers call **rapture of the deep**, or **nitrogen narcosis**. So much nitrogen was dissolved in his blood that it made him feel and act silly. His handwriting was very shaky.

"It can be very dangerous for a scuba diver to experience this," Dr. Sanchez explained. "He's unable to perform even simple tasks like writing. That's why skin divers are advised not to dive below 150 feet." They couldn't stay long at that depth. They were getting more and more nitrogen in their blood, and it would take a long time to get it out.

Before they left the "bottom," Ben blew just a little of the high pressure air into something he had kept folded in his duffle bag.

Coming up was kind of fun. Ben's ears cleared by themselves. The chamber got cold. In fact, it got so cold that moisture in the air **condensed** and a fog formed! They had to make a decompression stop at 10 feet for 24 minutes. This allowed the nitrogen in their blood to come out slowly. They breathed pure oxygen from masks to help cleanse the blood of nitrogen faster. Without these precautions, the nitrogen would bubble out and cause the bends, which is painful and life-threatening.

Ben returned safe and sound, but he had created a monster with one of his experiments!

By the time they reached the surface, what had been folded up in Ben's duffle bag was now Godzilla! When Jack swung open the heavy door to the chamber, he was pretty surprised when this huge inflated monster was the first to emerge.

Ben climbed out of the chamber right behind Godzilla. Sea level, at last. He was relieved to be back to one atmosphere. And he was especially relieved that his head was the same size as when he left.

"GLUB...GLUB...GLUB"

People have been diving for at least three thousand years. They dove for food, sponges, shells, coral, pearls, treasure, to repair ships, and to sabotage enemy ships. Now people also dive to build bridges, tunnels, and oil wells, for scientific research and for the adventure of exploring new worlds.

Early divers had no diving equipment. They learned to hold their breath for minutes at a time. For hundreds of years, inventors have struggled to help humans survive under water. Leonardo da Vinci (1452-1519), the great painter and inventor, suggested sacks of sand for **ballast** and a "wine-skin to contain the breath." A wine-skin is a soft, water-proof sack, usually made from the skin of a goat, used for holding wine. Could da Vinci's design for a wine-skin air tank work? Why?

EPISODE

[illegible] THE [illegible]

Pepper was alarmed. The wind was blowing *Mimi* towards the cliffs. She figured she had five minutes, tops, to find a way to keep the boat from crashing on the rocks. And to save Segovia and herself.

"What is the problem, Pepper?" Segovia asked anxiously, as they rushed back on deck.

She explained that the anchor line must have broken. She couldn't start the engine because the starter motor was dismantled, and they'd never get the sails up in time.

Pepper grabbed a grappling hook and tied a line to it. It was way too light for a boat the size of *Mimi*, but it was their only hope. Maybe it would catch on a **coral head**.

She tossed the hook over the side and watched the line play out fast. "*Come on*," she urged it, "*hold!*" Suddenly the rope went taut. "Yeah!" Pepper exclaimed, as she tied it off. She couldn't believe how close the cliffs were. Much too close for comfort.

She spent most of the night fixing the starter motor. It was morning when finally, weary and dirty, she stuck her head up through the engine room hatch and asked Segovia to turn the key. The engine roared to life. They both laughed, relieved.

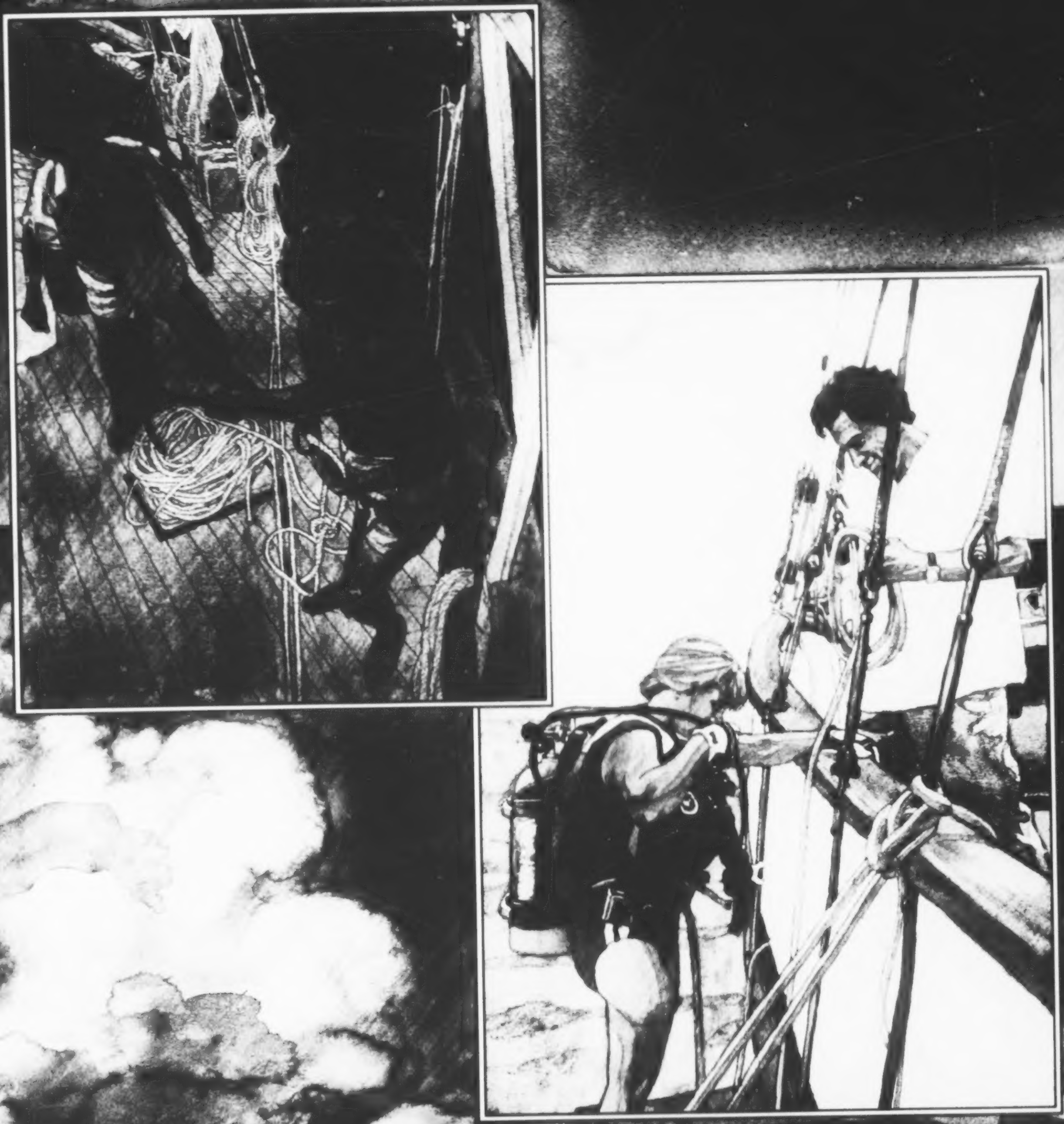
Later, after *Mimi* was safely back in deeper water, Pepper put on her scuba gear. Diving solo was never a good idea, so she tied a rope around her waist and gave the other end to Segovia.

"Three pulls from you and I bring you up like a fish," he said.

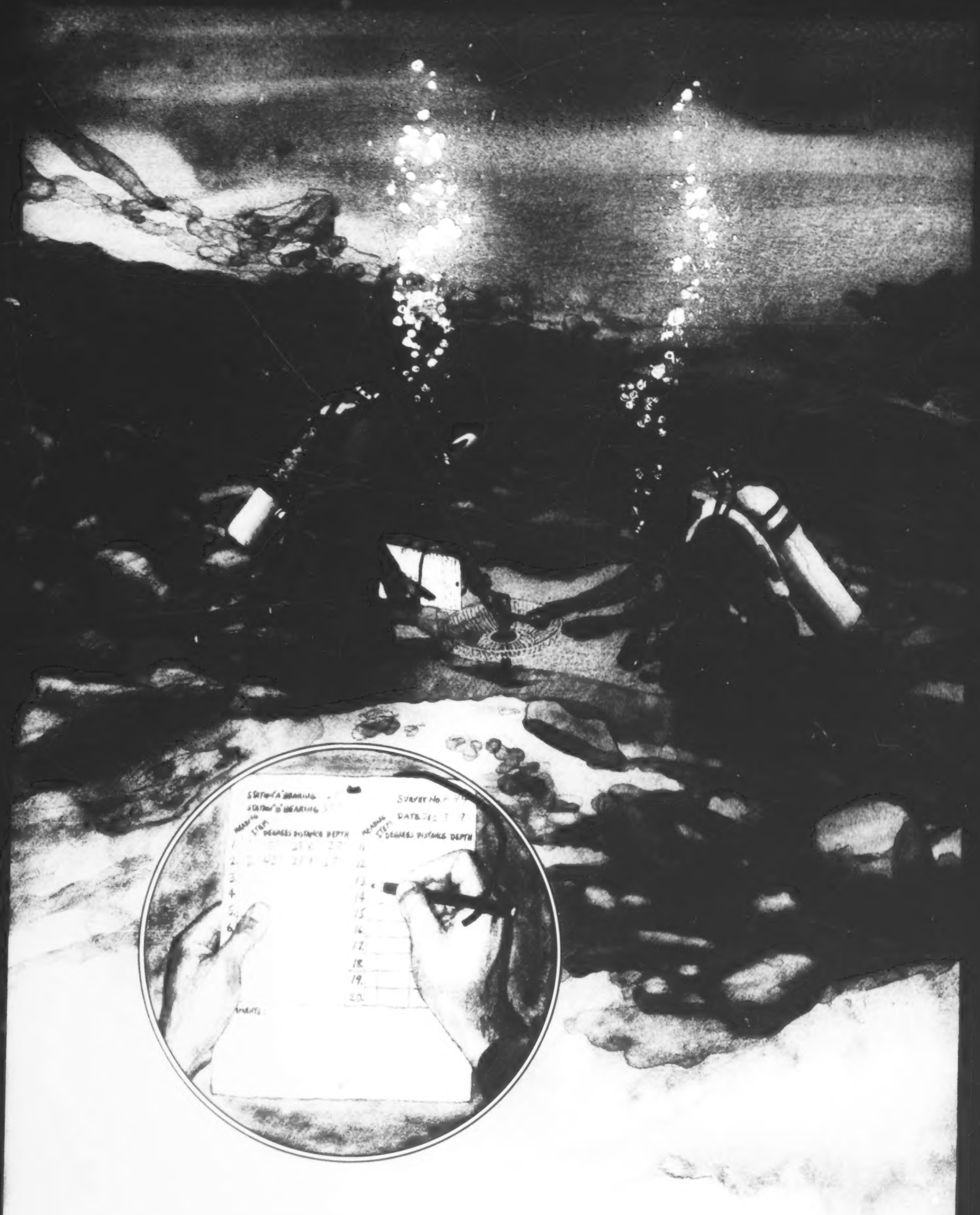
The water was warm and very clear. It didn't take her long to spot the anchor lying on the sandy bottom. It looked like the line had been cut. "On the coral?" Segovia asked her once she was back on the boat.

"I guess so," she answered, doubtfully. It was such a clean cut.

"It has been a very *interesting* visit," Segovia laughed, wiping his brow.



Pepper spent the morning re-fastening the anchor, making sure that the line wasn't near any coral. The others returned a few hours later. They were amazed to hear about Pepper's close call, and she was amazed to hear about their lucky break. "It's like in the movies," C.T. said, "only it's real!"


STATION 'A' BEARING
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"The part they don't show you in the movies," Terry said, pointedly, "is the work."

With that, they set about their duties. C.T. and Quiché helped Granny stow away the provisions they'd brought from shore. The others donned their scuba gear and spent the next few hours underwater. They were marking out a **polar coordinate** grid on the sandy bottom near the reef where they intended to start their exploration. It was slow, painstaking work. Victor stayed at the spot that was the center of their grid. Terry would swim to underwater "landmarks" with a tape measure and signal the distances to Victor. Victor recorded the information on his underwater writing tablet: depth, distance, direction. It was so beautiful down there, it hardly seemed like work.

Meanwhile, Quiché was teaching C.T. the Maya number system. She drew a dot. "This is one..." Another dot. "This is two..." And two more. "Three, four..."

"O.K., O.K., I think I've got that, Quiché," C.T. said, giving her an impatient look.

"Oh yeah? So what's five?"

That's pretty obvious, C.T. thought, as he drew five dots in a row. "Wrong!" Quiché proclaimed, drawing a short bar. "This is five."

Six, C.T. learned, was a bar with a dot above it. Ten was two bars, fifteen was three bars. "So this would be nineteen," C.T. said, and drew three bars crowned by four dots.

"*Hax tube*," Quiché said. "That's Mayan for perfect."

Now I get it, C.T. thought. He drew four bars. "Twenty!" he announced proudly.

"Wrong!" Quiché drew something that looked like an eye with a dot above it. "That's twenty," she said.

C.T. shook his head. "No wonder the civilization collapsed," he said. "Everybody probably flunked math."

Just then the divers returned. On the way back to the boat they had noticed a big opening under a rock. Pepper thought it might be the entrance to an underground stream that flowed out from someplace on shore. They didn't have enough air left to let them explore it any further. Maybe they'd check it out tomorrow.

Granny cooked dinner that night. Mexican beef stew, he called it. Anything to keep Pepper from making more of her flame-thrower chili. The only Mexican thing about his stew was that he served tortillas with it.

Quiché and C.T. had prepared some predinner entertainment. C.T. had figured out a computer program that could translate numbers from Arabic to Maya. They billed it as the only computer in the world, or at least in Tulúm, that could speak Mayan.

"A number from the audience, please," Quiché announced, starting the show. "Any Arabic number between one and twenty."

"*Ocho*," Victor volunteered.

"An eight, please," Quiché said, dramatically. C.T. entered the number, and within seconds the Maya version appeared on the screen: a bar with three dots above it. Five plus three.

Everyone was pretty impressed, especially Pepper. She'd never seen Maya numbers before. Granny thought it looked like Morse code—dots and dashes.

Pepper asked the computer for a twelve. Two dots above two bars appeared. "Nifty," she exclaimed. She was holding C.T.'s pot, helping herself to a tortilla. The pot was covered with glyphs. Wasn't that a twelve there? She showed it to Quiché. It was a twelve, all right.

Quiché had never really looked at the pot before. Not closely. Now she held it up and studied it. It didn't look like all those cheap souvenir pots. It looked. . .*real*.

Victor took it and examined it. "There are more glyphs on the bottom," he said, getting excited. "*Si, si*."

"What does it say?" everyone wanted to know.

"It says. . ." Victor answered, a twinkle in his eye, ". . .made in Japan!"

Everyone but Quiché chuckled. She was *serious*. Victor handed the pot to Terry, the pottery expert. She looked it over carefully. Her expression changed. "This little gem just could be real," she said, finally.

"So it is a prize catch, after all," Granny said. *Could* be, was all Terry would say.

Quiché was convinced the pot was real. She kept looking at it as everyone else ate. Not all glyphs were signs for things, she remembered. Some were syllables. These looked like syllables: *chac. . .ba. . .la. . .ma. . .* Those sounds seemed familiar.

Of course! Chac Balam. *Chac Balam*! Suddenly everyone was excited. Pepper couldn't understand why, so C.T. told her what they had figured out: Chac Balam was the king of Cobá mentioned on their stela; he was captured and taken to another city, the lost city; nobody knew what happened to him there; what they did know was that the half of the stela they found underwater must have been stolen by looters.

"There must have been looters right *here*," C.T. concluded.

Victor wanted to know where they had found the pot, so C.T. checked the ship's log. He went to the computer and typed in a command. Up came the log. Terry was amazed. So that was why there was a computer on board.

"You're welcome to use it," Granny said.

"Nothing like being drawn into the eighties on a nineteen thirties sailboat," Terry said, laughing.

It turned out that they had found the pot just down the coast from Tulúm. "Then it could have been looted too," Terry said.

Captain Granville had a theory. He told the others about the mysterious boat he and Pepper had seen the first night. It had taken off fast when he hailed it. Something had fallen off the stern, he remembered, something big and heavy. He had thought nothing of it at the time, but now. . .

"The stela!" Victor said. Of course! "That dark boat was looters, big-time looters."

"They must operate out of here all the time," C.T. joined in.

"Using those temples as lighthouses," Granny concluded.

It was all falling into place. Even Pepper had some evidence. She showed them the anchor line. Granny saw immediately that it had been cut—cut by a person with a knife, not by the coral.

"*¡Desgraciados!*" said Victor.

"Wow!" said C.T.

"Hold on a minute, folks," said Terry. "Let's not jump too far."

The Captain agreed. It was all just a theory. Was there any way to check it out?

Terry suggested they go to INAH in Mérida. They'd be able to test the pot at the archaeology labs, to make sure it was authentic. And they'd be able to file a report about the looters. They would dock *Mimi* up the coast, in Playa del Carmen, so they could all go, including Pepper.

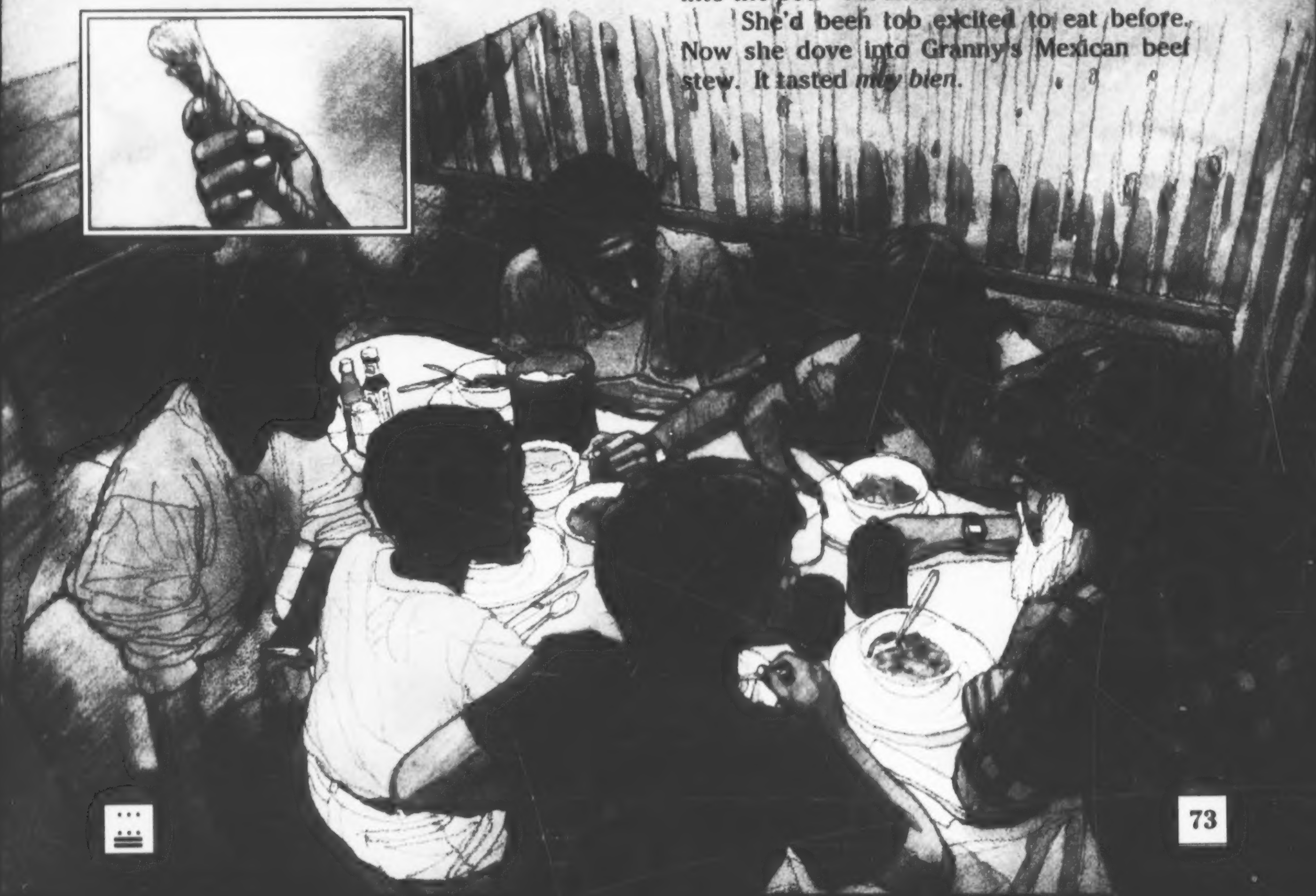
C.T. couldn't believe it. At this rate, he'd get to see the whole Yucatán Peninsula before this trip was over.

"Can I see the pot again?" Quiché said.

"You see something else?" Pepper asked.

"Yeah," Quiché replied, putting her hand into the pot. "An ancient tortilla!"

She'd been too excited to eat before. Now she dove into Granny's Mexican beef stew. It tasted *muy bien*.

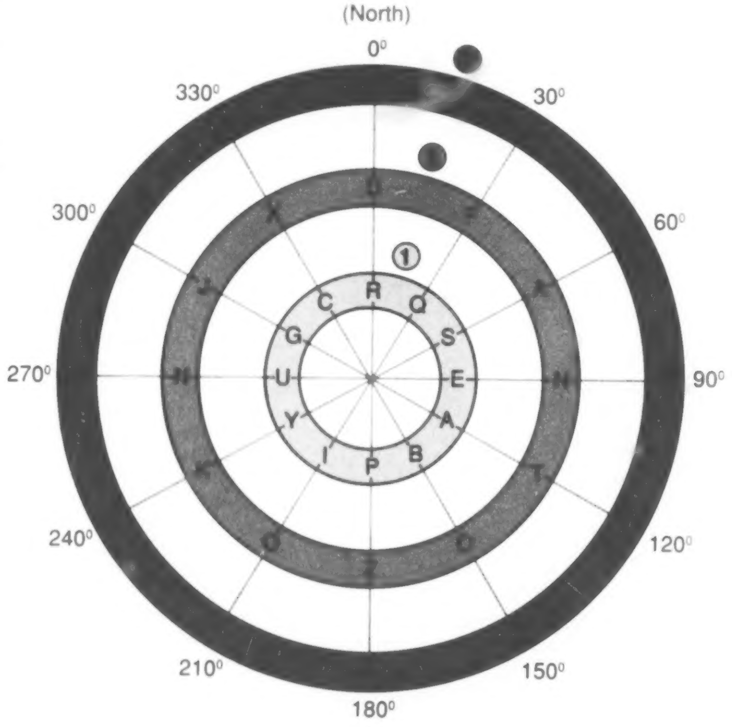


-ACTIVITY-

Secret Messages

In this episode, Terry and Victor and Pepper do some underwater mapping, using polar coordinates. With polar coordinates, if you choose a center point and you know where north is, you can specify any location as a distance and a **bearing** from the center.

A **Cartesian coordinate** system is different. There, you mark out a grid using vertical and horizontal lines that look like graph paper. Label the horizontal lines "1,2,3,4" and the vertical lines "A,B,C,D" and you can name points as "1A" or "3C" so anyone looking at the grid will know where you mean. (In Episode 2 Victor was mapping the jungle around Palenque using a Cartesian coordinate system.)



The polar coordinate system is often used for mapping difficult terrain and for surveying. However, we've discovered another use for it: sending secret messages in code! In the polar coordinate grid below, letters of the alphabet have been placed at the places where bearing lines and distance lines intersect (cross). On a piece of paper, write down, in the order given, the letters found at the intersections of the coordinates listed. The letters will spell out the answers to these riddles.

Riddle 1. Where do extra smart frankfurters end up?

Coordinates for Solution to Riddle 1

1.	150°; 2
2.	270°; 2
3.	90°; 3
4.	270°; 3
5.	90°; 1
6.	270°; 3
7.	210°; 2
8.	90°; 2
9.	210°; 2
10.	30°; 3
11.	0°; 1
12.	150°; 2
13.	60°; 3
14.	60°; 3

Riddle 2. What has six legs, bites, and talks in code?

Coordinates for Solution to Riddle 2

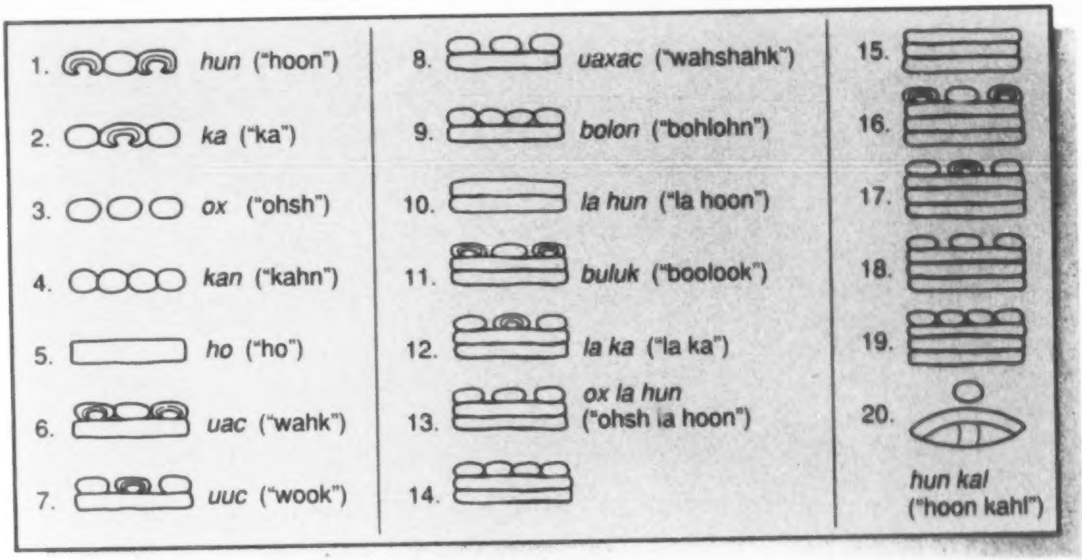
1.	120°; 1
2.	0°; 3
3.	150°; 2
4.	30°; 3
5.	300°; 3
6.	330°; 3
7.	30°; 1
8.	270°; 1
9.	210°; 3
10.	120°; 2
11.	210°; 2

If you and a friend each have a copy of this grid (or if you make a new grid, with the letters in different places), you can send each other coded messages.

MAYA MATH

Here are the Maya numbers from one to twenty. Crescents are sometimes used to take up space so the glyph looks symmetrical. They don't stand for any number.

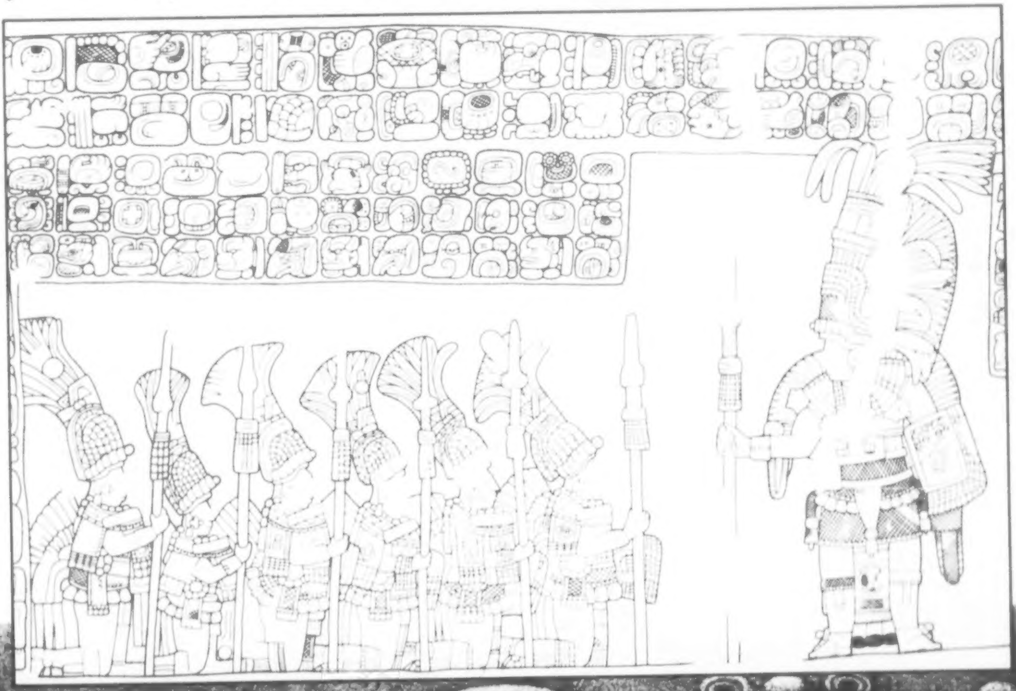
The Maya words for most of the numbers are given. These numbers work just like ours: "Fourteen" is "four" and "ten" in English and it would be "kan la hun" in Mayan. "Kan" is four and "la hun" is ten. Figure out the Mayan words for fifteen through nineteen.



1.	*hun* ("hoon")
2.	*ka* ("ka")
3.	*ox* ("ohsh")
4.	*kan* ("kahn")
5.	*ho* ("ho")
6.	*uac* ("wahk")
7.	*uuc* ("wook")
8.	*uaxac* ("wahshahk")
9.	*bolon* ("bohlohn")
10.	*la hun* ("la hoon")
11.	*buluk* ("boolook")
12.	*la ka* ("la ka")
13.	*ox la hun* ("ohsh la hoon")
14.	
15.	
16.	
17.	
18.	
19.	
20.	*hun kal* ("hoon kahl")

See if you can find and decipher the numbers on this drawing. The picture is of a carving from a Maya temple in Guatemala.

Mayan numbers can be written sideways or up and down . You'll find examples of both in this picture.



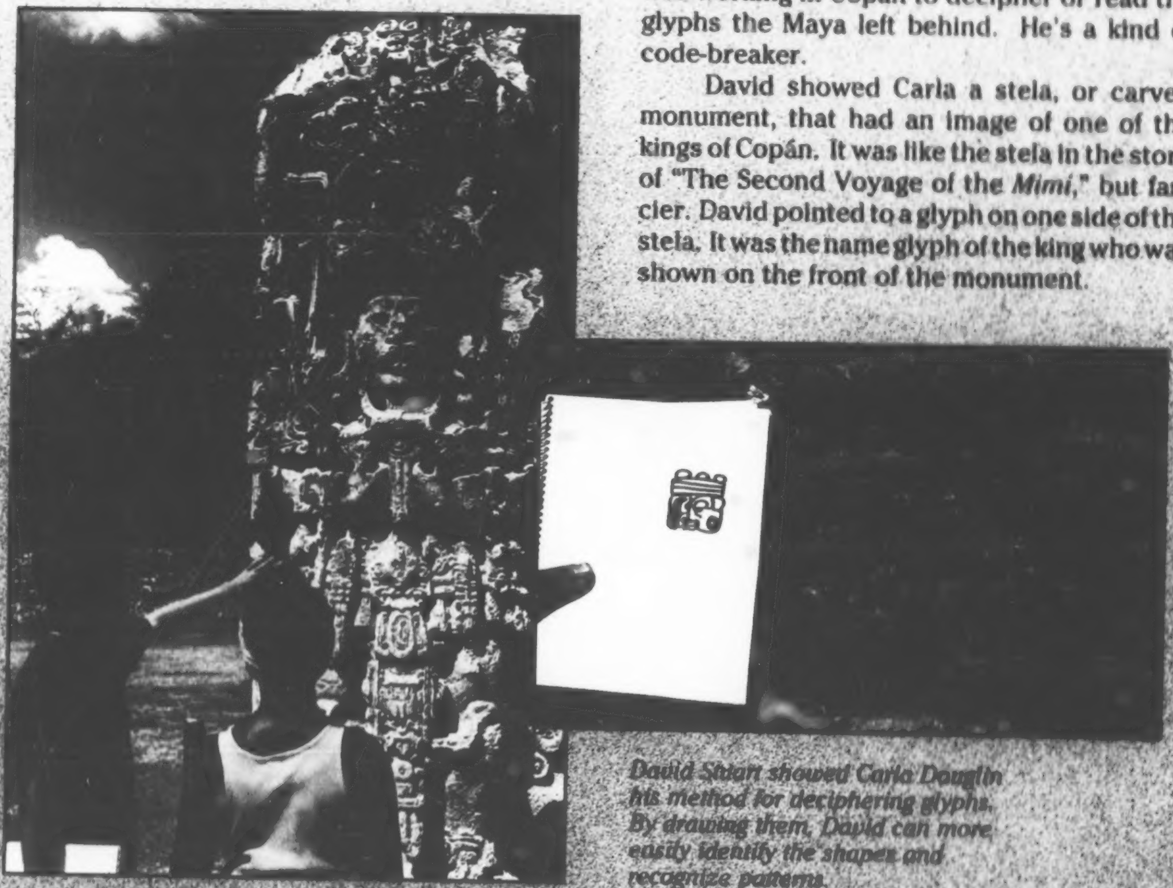
EXPEDITION

Copán was once one of the greatest Maya cities. It was also one of the furthest south, two hundred miles from Palenque and Tulúm. Now it's a spectacular ruin in the country of Honduras. Carla Douglin, the actress who played Quiché in "The Second Voyage of the *Mimi*," and Ben Affleck visited Copán. Archaeologists are studying the ruins to find out more about ancient Maya culture.

One of the people there was a young man named David Stuart. Carla was especially eager to meet him, because David was the model for the character of Quiché in "The Second Voyage of the *Mimi*." David's parents are both archaeologists. As a child, he spent a lot of time in Mexico with them, just as Quiché did. By the time he was eleven he was a real expert on Mayan hieroglyphic writing.

Now David is a college student, and he was working in Copán to decipher or read the glyphs the Maya left behind. He's a kind of code-breaker.

David showed Carla a stela, or carved monument, that had an image of one of the kings of Copán. It was like the stela in the story of "The Second Voyage of the *Mimi*," but fancier. David pointed to a glyph on one side of the stela. It was the name glyph of the king who was shown on the front of the monument.



David Stuart showed Carla Douglin his method for deciphering glyphs. By drawing them, David can more easily identify the shapes and recognize patterns.

"We call this fellow 18-Rabbit," David said. "That's his name." He pointed out some bars and dots on the side of the glyph. "Three bars and three dots. You know the way the Maya wrote numbers: each bar means 5 and each dot means 1."

"Eighteen," Carla interrupted.

"Right," said David. "And the rabbit is actually this part here." He pointed out a mouth, an eye, and the place where the ear would have been. But Carla couldn't really see the shape of the animal.

David also used to have a hard time picking out the details from the rock. He found that by drawing the things he saw, he could more clearly see the lines and begin to understand what they were. He took out a pad and marker and drew the rabbit glyph for Carla. Suddenly, it became easy to pick out the shape of the rabbit and some other details in the glyph.

"So this is his name," David explained, "and the other glyphs in this inscription tell you about the event that happened—sort of like one big sentence."

David showed Carla another important glyph on the stela. This glyph was in the shape of a human hand. There seemed to be dots falling from the hand, between the thumb and forefinger. David said they probably represented blood! "So it's a hand sprinkling blood. That, we think, is the glyph for the **rite** of bloodletting. The king pierced himself and let his own blood."

This was an important ceremony for Maya kings, though no one is sure why. It may have had to do with offering royal blood to the gods.

Carla was curious about the date the event described on the stela occurred. David said he'd need a computer to figure out what the date was on our calendar. But on the Maya "Long Count" calendar, the date read: 9 *baktuns*, 15 *katuns*, 0 *tuns*, 0 *uinals*, and 0 *kins*. All the zeroes indicated that this was a very important date in the Maya calendar. The king had celebrated the date by letting blood.

There were symbols on the glyph that David didn't know how to read. He and others still have a lot to learn about the written language of the Maya.

They moved to another stela, and Carla was able to pick out the glyph for 18-Rabbit herself. She was beginning to become a codebreaker. The trick is finding signs that show up in different glyphs and looking for patterns or meaning in each situation.

David pointed out another interesting glyph. This one had the face of a bat. The bat was the emblem of Copán, and this was the emblem glyph for the city-state of Copán. The glyph contained several different signs besides the bat. Just above the bat was the sign for the Maya word *ahau* which means "king" or "ruler." In front of the bat was a series of dots.

Carla remembered that dots could mean numbers or blood. David said in this case he thinks they represent blood. Together, the signs for "king," "blood" and the emblem "bat" seem to read, "18-Rabbit was the king of the bloodline or the **dynasty** of Copán."

Though David is an expert on Maya writing, he is just learning about other aspects of archaeology. His teacher at Copán was Bill Fash, the head archaeologist of this expedition. Ben Affleck toured Copán with Bill.

Bill and Barbara Fash use a large sandbox to move pieces of stone and sculpture around in order to figure out how they might have fit together.

(Right) The hieroglyphic stairway on Temple 26 tells the history of Copán. (Below) Archaeologists at Copán call this the "God-only-knows-pile."

"This is Temple 26 with its famous hieroglyphic stairway. It has the longest hieroglyphic inscription in the New World," Bill told Ben. The stairway tells the history of the city, from the earliest kings through the fifteenth king. His name was Smoke Shell, and he's shown on the stela in front of the stairway.

The archaeologists are trying to put Temple 26 back together. Everything they dig up has to be drawn, photographed, and catalogued. Nothing is put into the building unless they are sure it belonged there. Sometimes it's difficult to know where the pieces belong.

Bill pointed to a huge mound of carved blocks of every shape and size. "This stuff came out of five different temples and was piled here by earlier archaeologists," he told Ben. "But we have no idea where any of these things came from."

Bill and his wife Barbara have invented a way to put some of the big pieces of sculpture back together. They put them in a sand box so they can move them around and try different ways. It's like fitting together pieces of a puzzle—a very heavy puzzle.

Most of the workers who are actually rebuilding the temples at Copán are Maya. They've become experts on the archaeology of their ancestors by working on the site for many years.

Archaeologists have been working at Copán for nearly a hundred years. But it's still possible to make some amazing discoveries. In fact, David made one.

Bill had given David the chance to supervise some digging under the hieroglyphic staircase. He had never done that before. He is still a student, after all.

He told Ben and Carla what happened. "All of a sudden one of the workmen called me over and said, '*¡Ceramica, ceramica!*—a pot! a pot!' And I came down and looked at it, and there was just a little piece of it that he had nicked away with his pick. It was clear that the thing was whole. And so we spent the rest of the day exposing it. We realized how important it was because it was a really big pot."

In the small lab at Copán, David and Bill showed Carla and Ben what they found inside the pot. There were several pieces of beautiful carved jade. Bill said these treasures left behind by Smoke Shell and discovered twelve hundred years later were the most spectacular ever found at Copán. There was also a plain shell with something brownish inside. The archaeologists think it might be human blood from the bloodletting rite that the king did when he dedicated the building.

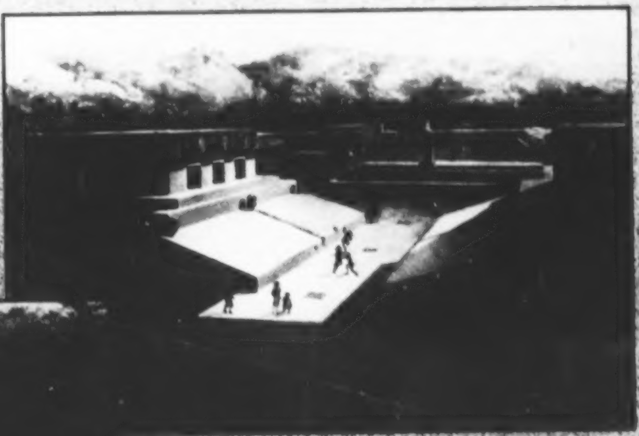
The brown substance in the shell may be human blood from an ancient bloodletting ceremony.

David is as interested in solving puzzles as he is in finding treasure. The last thing he showed Carla and Ben was another puzzle.

The great ball court at Copán is one of the best-preserved anywhere. But no one knows exactly how the game was played. The Maya probably used a rubber ball, and the game might have been between two people. Maybe the kings played each other.

Ben and Carla tried to guess how the court was used. Perhaps the slanted sides were bleachers where people sat. David said he thinks the ball was bounced off the sides and people sat around the court. Big stone parrot heads on the sides of the court might have been markers of some kind.

We may never know much more about the Maya ball game. A lot about the ancient Maya will always be a mystery. But for people like David and Barbara and Bill, solving mysteries is what archaeology is all about.



This reconstruction painting by Tatiana Proskouriakoff shows how the ball court at Copán might have looked in ancient times.

The ball court at Copán as it looks today. How the ball game of the ancient Maya was played is one of the puzzles archaeologists are trying to solve.

WHAT'S *NOT* CARVED IN STONE?

"We found a large number of books of these characters [hieroglyphics] and, as they contained nothing in which there were not to be seen superstition and lies of the devil, we burned them all...which caused them much affliction."

This was written by a Spanish priest who governed the Maya. Spanish warriors, known as conquistadors, came to Mexico in the 1500's in search of gold. They conquered the Maya, killing and enslaving many. Spanish priests were horrified at the Maya religion, especially the idea of human sacrifice. They burned all the Maya books they could find. Only three books survived. Except those three books, the only place we have been able to see Maya writing is on ancient monuments and in paintings.

Walk around your neighborhood or a nearby city. Take notes on things you find carved in stone. What information do they give you? What kinds of things would you never learn about from them?

EPISODE

Mimi was tied up at the dock in Playa del Carmen. Everyone was busy with preparations for the trip to Mérida, five hours away by jeep. C.T. helped his grandfather cinch up the sail covers.

"Boy, my vacation sure is turning out different than I planned," he said, tying off a line. "I came down for another voyage on *Mimi*, and now I'm looking for a lost city."

Not that he minded. He was seeing so many new places and people. And he was certainly on a *voyage*, only this time the vessel was a jeep instead of a boat. Quiché had decided to christen the jeep, and was busy stenciling something on the door. C.T. went over to see what she'd done.

It was a homemade hieroglyph. To C.T. it looked like a picture of a giant in a bathtub, blowing bubbles. Quiché explained that the "bathtub" was the way the Maya represented wooden boats; the big head was the god of the number two; and the two big dots, the "bubbles," also signified the number two, or "second." It was Quiché's glyph for "*Mimi II*."

Off they sailed in *Mimi II*, cutting due west across the Yucatán Peninsula. The only waves on this voyage were the friendly ones they got from the people in the villages they passed. C.T. spent part of the time bringing his journal up to date.

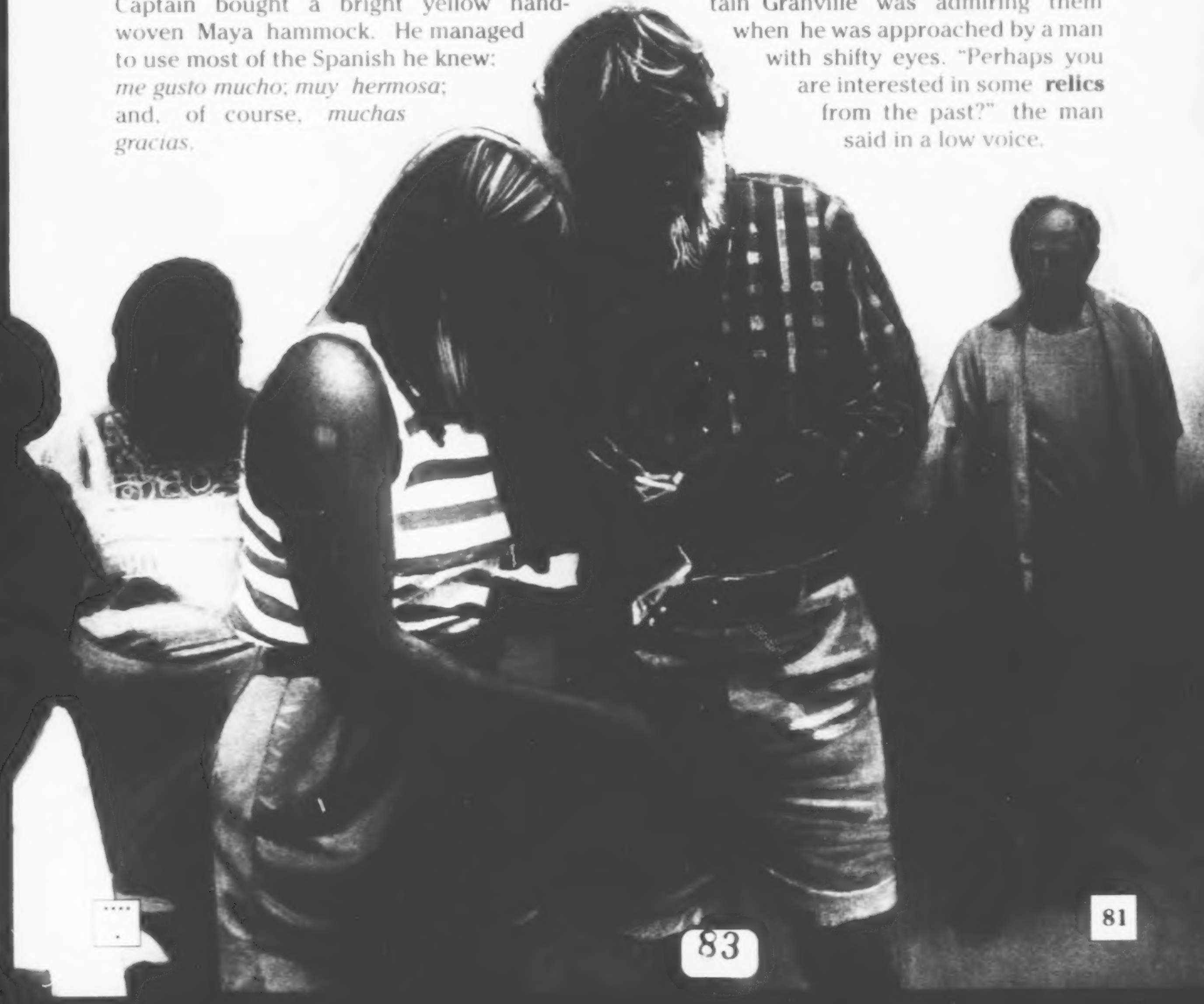
This is turning into a real detective story. So far we have two halves of a Maya monument, a lost king, looters, and a pot that could tell us even more. The trouble is, we don't know if the pot was made by the Maya fourteen centuries ago, or fourteen days ago. So here we are, heading for Mérida to visit the government archaeology offices. Maybe someone there can help us solve the mystery.

Mérida was a bustling city, the capital of the state of Yucatán. It looked a lot older than most cities back home, C.T. thought. As they drove around the central plaza, Victor pointed out an old Spanish *hacienda*. There were statues of conquistadors standing on the heads of dead Maya. C.T. didn't say much for a while.

While the others got right to work at the INAH labs, Pepper and Granny headed for the marketplace.

The *mercado* was a busy, colorful place, crammed with vendors and shoppers. The Captain bought a bright yellow hand-woven Maya hammock. He managed to use most of the Spanish he knew: *me gusto mucho*; *muy hermosa*; and, of course, *muchas gracias*.

They saw a machine that made tortillas. It looked like an old press, printing out hundreds of flat, round corn cakes. They smelled great, too. The fruit sellers had set up their oranges and lemons in tidy little piles. Captain Granville was admiring them when he was approached by a man with shifty eyes. "Perhaps you are interested in some **relics** from the past?" the man said in a low voice.



"No thanks," the Captain answered.

"Genuine Mayan," the man insisted.

The Captain repeated that he wasn't interested, but then an idea came to him. "Wait," he said. "Ancient Maya? Genuine?"

Shifty Eyes opened a little newspaper bundle to reveal a clay figurine inside. "Very genuine," he said. "Very old. Just found." Granny asked him if he had more. "*Si*," the man whispered, his eyes darting around.

At the lab, C.T. was sitting at a counter, scraping the bottom of the pot with a scalpel. They needed a sample of the clay for the test they were going to run to determine the pot's age. He wondered how much the pot would be worth if it turned out to be **authentic**.

"Fifteen, twenty thousand," Terry said.

"Dollars?" he asked, amazed. She reminded him that it was illegal to sell ancient artifacts. "Keep scraping," she said.

As he worked, Terry explained that they would be conducting a **thermoluminescence** test. It actually wasn't that hard to understand, considering how long the word was.

First she explained that clay is made up of different materials. Some of those materials are **radioactive**, but only in tiny amounts—not enough to hurt anyone. Other material in the clay stores energy when it is hit by radiation. So far so good.

Next she described how that energy would be released any time the clay was heated to very high temperatures. Their test would involve heating the clay sample and measuring the energy released.

C.T. didn't see how that would tell them how old the pot was. Terry reminded him that when the pot was made, however long ago, it was fired in a **kiln** to harden the clay. That released all the energy the clay had stored up to that point, so the new pot had zero stored energy when it came out of the kiln.

The pot hadn't lost the radioactive material in the clay, however, so it began storing energy all over again. Any energy in it *now* had been building up since the day it was fired. The more energy they measured, the older the pot. The test could clearly distinguish between an old pot and a new one.

"Thermo" means "heat," and "luminescence" is the light, or energy, released by the clay. C.T. hoped the pot would release a lot of luminescence. It would prove what he'd thought all along—that his pot was real.

Meanwhile, Shifty Eyes led Granny and Pepper to the back room of a **curio** shop near the market. He unlocked a closet, revealing several shelves of Maya pottery and figurines. When a bell summoned him to the front to take care of some customers, Pepper quickly took some pictures of the artifacts. "This looks like the real stuff," Granny whispered, as he acted as lookout.

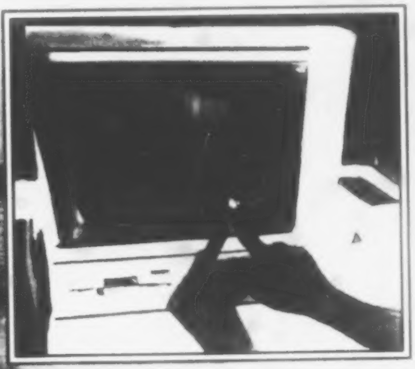
Soon Shifty Eyes returned. He showed them a figurine, but wouldn't tell them where it was from. Just then they heard footsteps; they turned to find Harvey Westerman standing in the archway, staring at them.

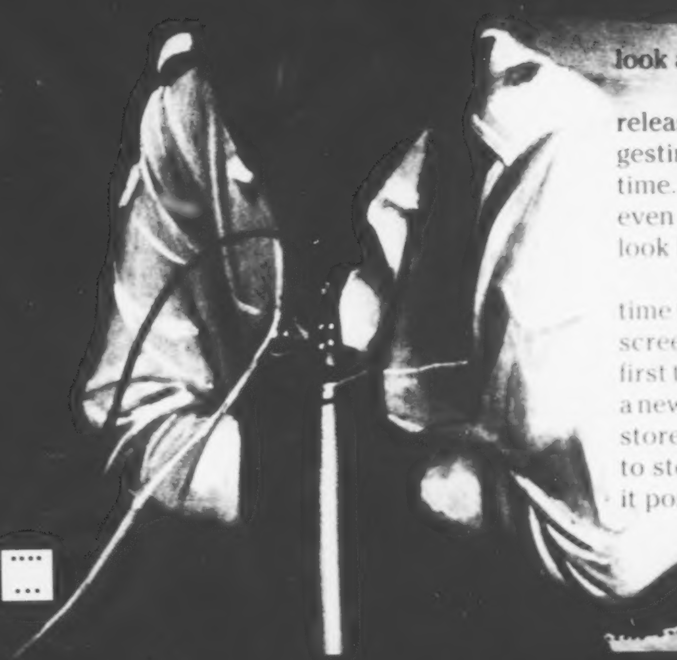
Westerman sent his assistant away and turned to Pepper and Granny. He asked them why they were there, and Granny replied that they were interested in Maya relics. Westerman said his assistant had been trying to cheat them by selling them worthless copies.

"Fakes?" the Captain asked, doubtfully.

"Of course," Westerman replied, locking the closet. "As I'm sure you're both aware, it is *illegal* to deal in pre-Columbian antiquities."

At the INAH lab, Terry spooned the clay sample into the heating chamber. They were ready to start the thermoluminesence test. Victor pushed some buttons on the control panel, and they all leaned in to watch the computer screen. As the temperature increased, the graph line shot up dramatically.





"Well, well, well," Terry said. "Will you look at that!"

The graph indicated that the clay was releasing a lot of energy as it got hotter, suggesting that the pot had been around for a long time. They still had more tests to perform, but even Victor admitted that it was beginning to look like their pot was the real thing.

They tested the sample again, but this time the graph line lay flat at the bottom of the screen. All the energy had been released the first time, proving what Terry had said earlier: a new pot, just fired, wouldn't have any energy stored in it; only as time passed would it begin to store energy again. And that's what made it possible to date the pot.

From the lab they went to visit Jean Andrews, who lived in Mérida when she wasn't at Cobá. She wanted to run all the evidence "through the old brain cells again." One: part of a stela had been stolen from Cobá and dropped in the water off Tulúm, probably by the looters. Two: the stela indicated that Chac Balam, a king of Cobá, had been captured and taken to Site U. Three: they now had a pot, also dedicated to Chac Balam, also found underwater, and also, apparently, looted.

Did that mean the pot was also from Cobá? It didn't look like other pottery they'd found there.

"This might help," Quiché said. She had made drawings of the glyphs on the pot and filled in the lines that had faded. Now she could tell that the "twelve" Pepper had noticed earlier was part of a date glyph.

Victor rushed over to look. She was right. And what was interesting was that the date was two years *after* the date on the stela marking Chac Balam's capture. Next to the date was the glyph for "capture." Victor was getting excited. "Think about it," he said. "This pot celebrates his capture two years *after* it happened."

"But they wouldn't be celebrating that in Cobá," Jean said.

"That means," C.T. announced, beaming, "that the pot must be from the lost city!"

"*¡Exacto!*" Victor said.

"Good work, Quiché," her mother said proudly.

They still had no idea where the lost city was, of course. The first step in finding it would be to analyze the clay in the pot. If they could find out what area the clay was from...

Terry typed in a command on the computer. They had a database of all the locations where the Site U emblem glyph had been found. She scrolled quickly through the data. The glyph, it seemed, had always been found south of Cobá. That didn't exactly pinpoint the site, but it was a lead. At least they now had a general idea of where they should look.

Pepper and Granny soon joined them, and told of their encounter with Westerman. They examined Pepper's photos, and C.T. recognized the Site U glyph on one of the pots.

"That means Westerman has already found the lost city," Quiché said mournfully.

They would have to work fast. If the relics in his shop were all he had looted so far, Jean argued, he probably hadn't done much harm to the site yet. But now he knew they were suspicious of him, and would rush to steal as much as he could, as fast as he could.

There was no point in telling the police yet. They had no hard evidence, and they were sure that Westerman would hide the stuff they'd seen in his shop.

"We'd better find that lost city," Granny said, his voice urgent, "and in a hurry."

"I like your attitude, Captain," Jean said. "This is getting good, isn't it?"

C

WHOSE POT IS IT?

When C.T. finds out that "his" pot was really made by the ancient Maya, he immediately says, "I guess it's not mine anymore." But maybe a little voice inside him had some doubts.

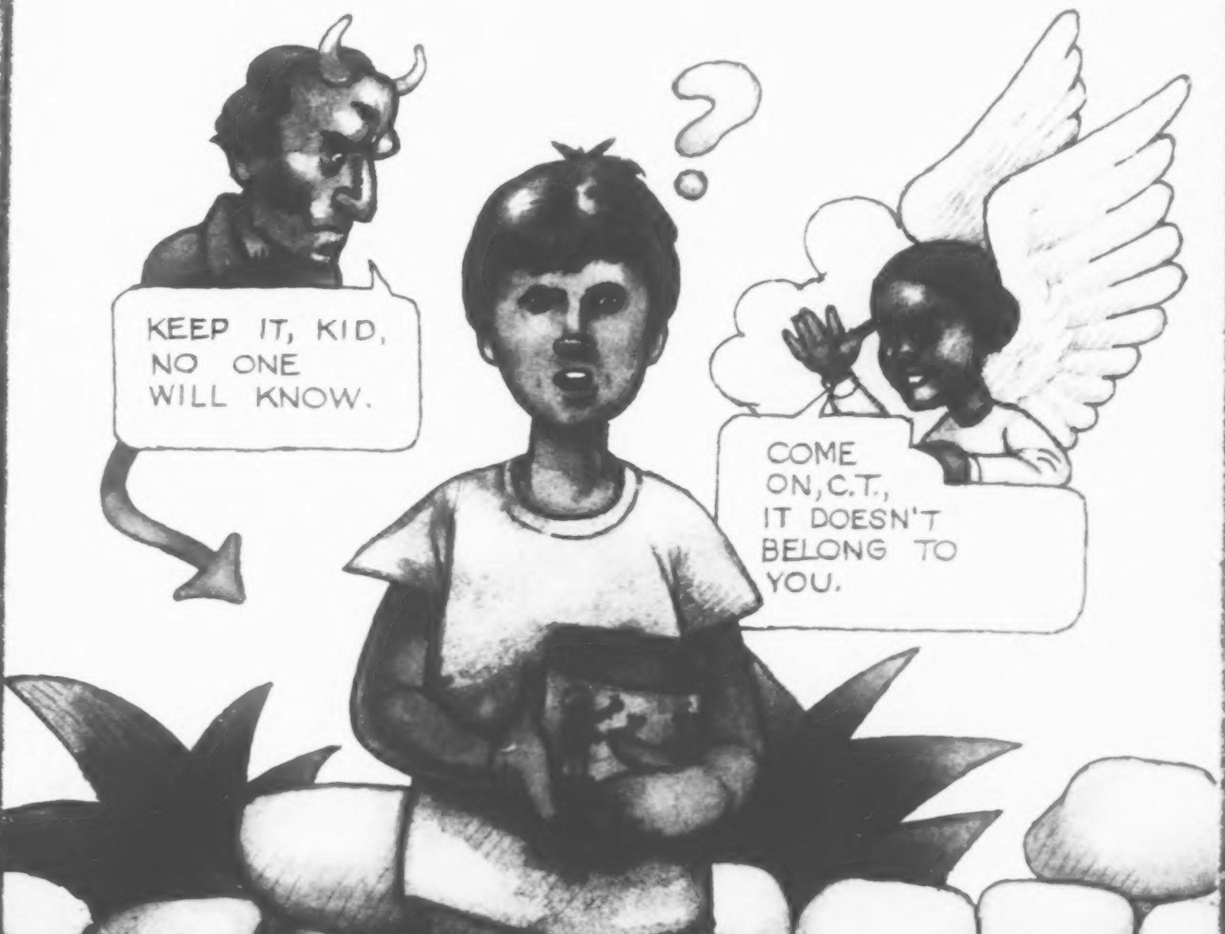
Write a dialogue between C.T. and an imaginary friend arguing about who owns the pot. Act out the dialogue with a friend. For example:

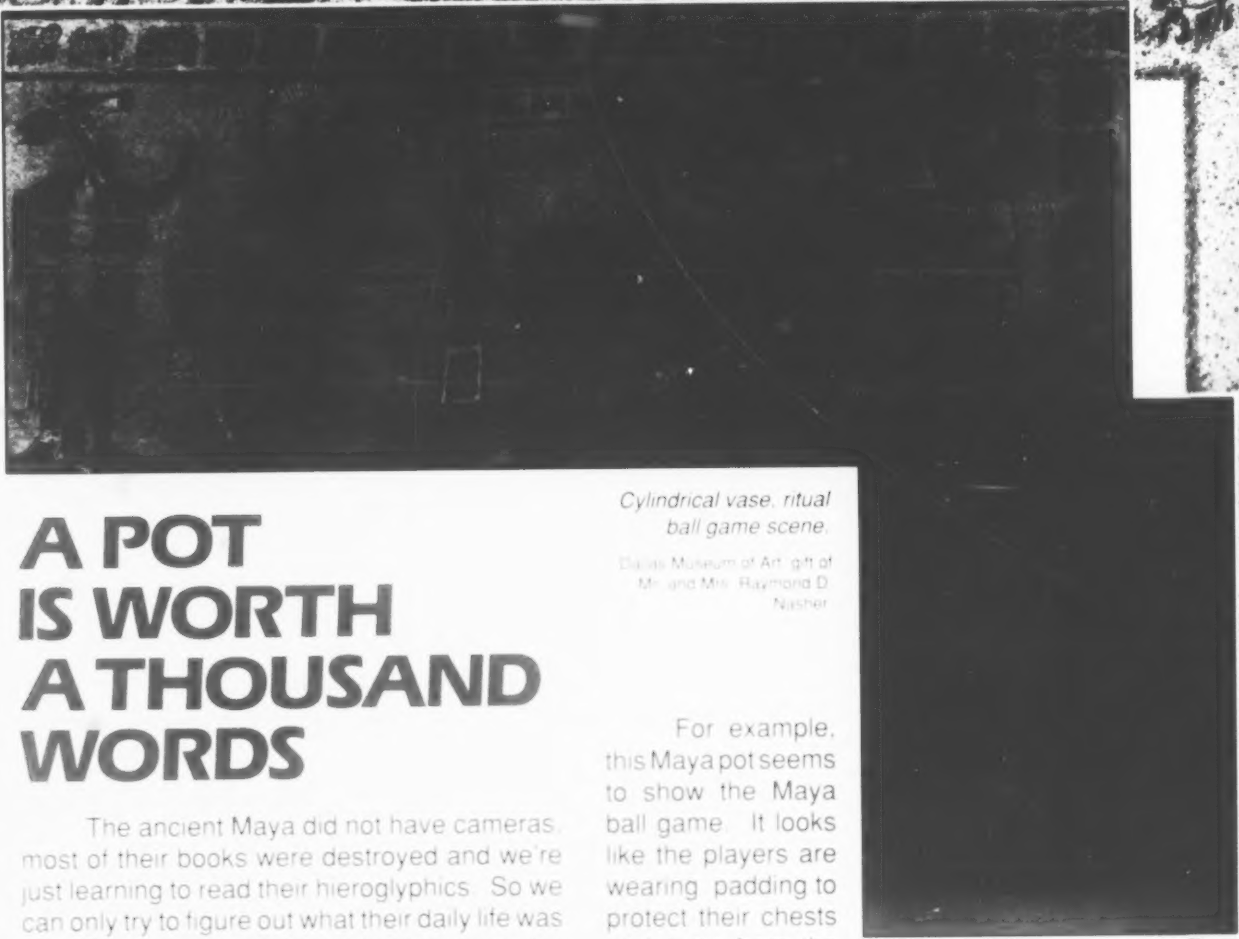
James: *C.T., you're a sucker. That pot belongs to you.*

C.T.: *No it doesn't. It was found in Mexico's waters. It belongs to Mexico.*

James: *You mean if I catch a fish in Mexican waters, it belongs to Mexico? Give me a break.*

What would you think if you were C.T.?


KEEP IT, KID, NO ONE WILL KNOW.
?
COME ON, C.T., IT DOESN'T BELONG TO YOU.



Cylindrical vase, ritual ball game scene.

Dallas Museum of Art, gift of Mr. and Mrs. Raymond D. Nasher

A POT IS WORTH A THOUSAND WORDS

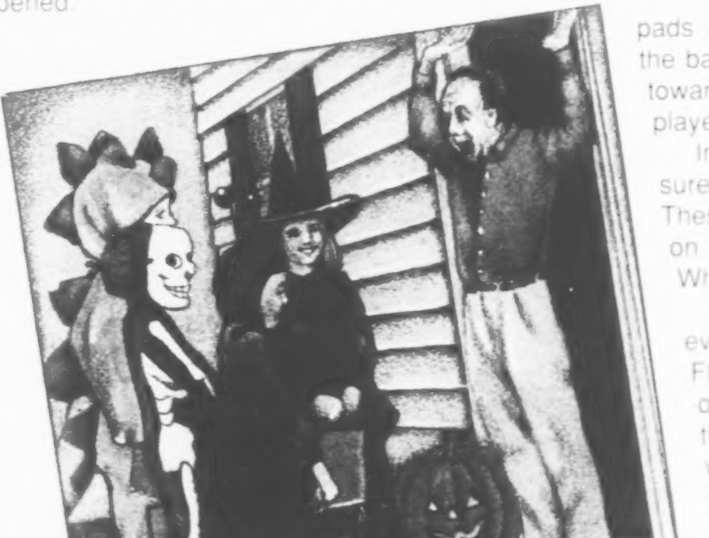
The ancient Maya did not have cameras, most of their books were destroyed and we're just learning to read their hieroglyphics. So we can only try to figure out what their daily life was like. One key is the images of people carved in stone or painted on ceramics by Maya artists. We do our best to interpret these, based on the evidence, but no one knows for sure what happened.

For example, this Maya pot seems to show the Maya ball game. It looks like the players are wearing padding to protect their chests and arms from the massive ball. The ball itself is black, the color of natural rubber that has been cooked and solidified.

Was the ball bounced off chest pads and along the slanted walls of the ball court? Does the ball moving toward one player's face show that player is about to lose?

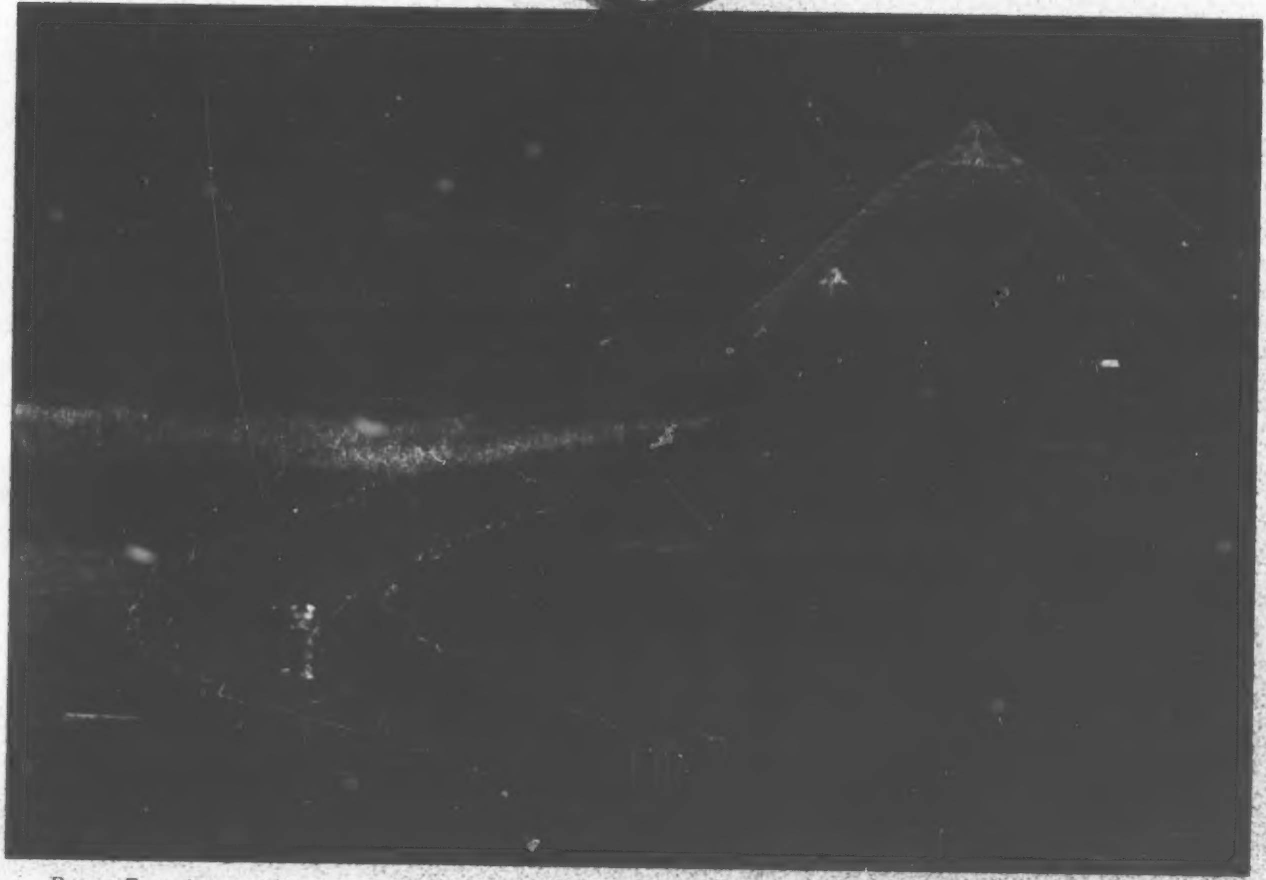
In fact, not much is known for sure about the Maya ball game. These interpretations of the scene on the pot could be dead wrong. What else could be happening?

The picture at left shows an event that took place in Clermont, Florida, in 1988. If future archaeologists who knew nothing about this culture found this picture, what are some *wrong* interpretations they might make?



EXPEDITION

THE ANCIENT FARM



Butser Experimental Farm is an actual farm where Iron Age farming methods are used.

Archaeologists are like detectives, trying to put together a story based on clues. Often their clues are hundreds or thousands of years old. They can never be absolutely sure if their theories are correct.

Ben Affleck went to England to meet a scientist who is testing some archaeological theories in a different way. Dr. Peter Reynolds is interested in people known as the Celts (pronounced kelts). The Celts lived and farmed in southern England about two thousand years ago, during the **Iron Age**. That was even before the time of the great Maya civilization.

Peter Reynolds is trying to learn about Iron Age farming by actually doing it. He is the director of the Butser Experimental Farm, an actual farm where Iron Age methods are used.

"You're pretty familiar with the ordinary kind of archaeology, where we dig things up—pots, bits of bones, post holes, pits and all that," said Peter. An archaeologist digs all that stuff up, then makes up theories about what it means. Peter's job starts there. "We take the information from the archaeologist and say, 'If you think it means this, let's test it to see if you could be right.'"

Peter Reynolds raises farm animals the Celts raised and trains them to do farm work at Butser. These cows are being trained to pull a plow.

There are conflicting theories about Iron Age farmers. Roman historians described them as good farmers, providing wheat and other grains for all of Europe. More recently, archaeologists have suggested the Celts were barely able to raise enough food for themselves.

Peter uses Iron Age farming methods in order to figure out how much food the Celts could have produced. He builds houses and fences using the materials they used. He studies the **fossil** evidence and raises animals similar to those the Celtic farmers raised. Careful records are kept so Peter can figure out what was possible for the Celtic farmer.

Archaeological evidence, scientific knowledge, and common sense guide Peter in building the structures at Butser. For example, circles of post-holes found all over England told Peter how big an Iron Age house probably was, how many and how big around were the posts that supported it. Roman historians wrote that the houses were covered with straw thatch. Based on this information, Peter constructed a round house with a cone-shaped thatch roof.

Ben wondered how the Celts could have had fires inside this kind of house with no chimney or hole in the roof. Peter explained that a hole in the roof would be dangerous and impractical. There would be such an updraft from the fire that sparks would be drawn up into the thatch, creating a fire hazard. Besides that, it rains a lot in England. The rain would go through the hole and put the fire out.

With no hole in the roof, the smoke from a fire in the middle of the house would rise above the people's heads and **percolate** or filter out through the straw. Peter has tried it and it worked. The smoke also helps kill small insects that live in the straw and keeps mice and rats out.

Ben got a chance to see Peter add a layer of thatch to the building. "How do you know this is what they used in Iron Age times?" Ben wanted to know.

"Well, thatching is a tradition that goes back seven thousand years. Lots of houses in England are still thatched. I'm using the oldest known system of thatching which is called sewing." He wrapped a bundle of thatch with a string and tied it through to the rest of the roof, then pulled the string tight. "O.K., now we beat that a bit and tuck it down again. If we don't, we're going to get a little river between the two. Then that will go down into the straw and cause it to leak."

Peter conducted an experiment to prove the thatch wouldn't leak. He poured a bucket of water on the thatch. The drops of water moved down one piece of straw and were picked up by the next. The angle of the roof was just right to keep the water moving down along the straws instead of down through them.

The Celts grew wheat mainly for its seeds which were used to make bread. The stalks or straw were just by-products. Peter thinks the fact that they found a use for the straw as well is an example of Iron Age efficiency.

Ben was surprised that the thatch roof didn't leak.

Since the goal at Butser is to find out what kind of crop yields the Celts had, Peter and his staff have gathered the same species of cereals or grains the Celts grew two thousand years ago. Peter explained, "When we excavate sites, we find seeds that have been turned to carbon from fires—bonfires or accidents. And we can actually identify these seeds down to different species of plants. So we've been growing those species over the years."

Peter also uses Iron Age tools or replicas based on Iron Age tools in museums. He sometimes changes archaeologists' theories about them. One sickle has a long, curved blade and a short handle, similar to sickles still used in many places. It works very well to cut grain. Another tool that archaeologists thought was a sickle has a long handle and a short, thick blade. When Ben tried to cut grain with it, the roots of the plants were pulled out of the ground.

"That's no good for thatching," Peter said. "So I've come to the conclusion that that really isn't a sickle." Peter took out a piece of wood and demonstrated that the tool worked very well to split wood for fences and gates. That doesn't prove that Peter is correct, but it does make for an improved theory.

Peter has concluded that Roman historians were probably right. Iron Age Celts were very good farmers. His system produces two to four tons of wheat an acre, depending on the season and the climate. That's a better harvest than many farmers get today—even with the use of chemical fertilizers.

"All the archaeologists thought that in prehistory farmers struggled to survive, making just enough to keep living from year to year. That's called a **subsistence** society. My results show they could have produced a surplus."

Peter demonstrated how a tool usually described as a sickle worked better for splitting wood than for cutting grain.

If Celtic farmers produced a surplus of wheat, they must have had a way to store it. Peter thinks he knows how they did that, too. He showed Ben a pit with a ladder leading down into it. "We find these things all over the Celtic world. You can store grain down a pit like this with ease because all you do is fill it up with grain, put a clay plug on top, and cover it."

As the grain begins to grow, it produces carbon dioxide which fills the pit and stops any further growth. The temperature is kept low by the surrounding rocks. These are ideal conditions for grain storage. Peter has tested this theory for twenty years and it works perfectly every time.

In some countries today, including Australia and Argentina, thousands of tons of grain are stored underground in pits from three to twenty feet deep. Before Peter tried this experiment, most archaeologists thought the Iron Age pits were underground houses built and used by a "primitive" people. Peter is now convinced that the Celts were clever, productive farmers.

Ben had one more lesson at the experimental farm. Peter showed him another way the Iron Age farmers made use of every available resource. He set Ben to digging in the **daub** pit. Daub is used to reinforce the walls of buildings. It's made from clay, fiber, soil—and **dung**. Dung gathered from all the farm animals is an essential ingredient because it acts like glue.

Ben applied the daub to a wall with the best tool possible, his hands. Peter had convinced Ben that the Celts were better farmers than people used to think. But Ben wondered if kids back in the Iron Age liked daubing the walls any better than he did.

Daubing...a hands-on experience.

WHO WERE THE CELTS?

The Celts (pronounced kelts) were tribal people who lived in central and western Europe from about 500 B.C. to 50 A.D. Because the tribes were disorganized, they were eventually conquered by the Romans. Around the same time as the Romans conquered the Celts, the Maya cities were being built in Mexico.

Archaeologists have learned about the Celts from the remains of houses, farms, and tools. However, much of what we know about the daily life of the Celts comes from the writings of Greek and Roman travelers and historians.

For example, Romans who fought the Celts wrote of their terrifying appearance. Celtic warriors would soak their hair in a mixture of water and crushed chalk. Then they scraped it back toward the nape of the neck like a horse's mane. The hair appeared very light in color and dried so stiff and spiky that, according to later Irish folktales, you could spear an apple on it!

It seems that some Celtic men also bleached their hair. A hero named Cu Chulainn appears in one story with hair that is dark at the roots, red in the middle and golden at the ends. The dye he had used must have been growing out.

Julius Caesar wrote, "The British (Celts) tattoo themselves with Woad which produces a blue color and gives them a more horrible appearance in battle." Woad is a yellow wildflower, *Isatis tinctoria*, whose leaves yield a blue dye. The Celts used this dye to tattoo themselves and to dye their clothing. Additional proof of this came when evidence of blue dye was found on the preserved skin of an Iron Age body discovered in a peat bog.

The Celts loved feasting and fighting. Pork was their favorite meat; beer was a common drink.

EPISODE

A ROAD TO DANGER

A hot afternoon. [illegible] filled the forest: chirps, screeches, howls and trills. C.T. lay in the yellow hammock, writing in his journal.

December 19. Somewhere in the jungle south of Cobá. Siesta time. Things have been happening so fast that once we found out the pot was from Site U, I haven't had a chance to write much. I guess we got started in this direction when we took all our evidence to the government's director of archaeology in Mérida.

The director, a friendly man with a beard, had listened attentively while Victor and Terry made their case. They told him they believed there might be a major undiscovered site in the area south of Cobá. "Undiscovered by the *good* guys," Terry added wryly.

Chemical analysis of the clay in the pot had shown that it was similar in composition to clays found in that area. They wanted to explore the region, but first they needed the director's permission.

"That's still a very big haystack for your lost needle," he said, stroking his beard.

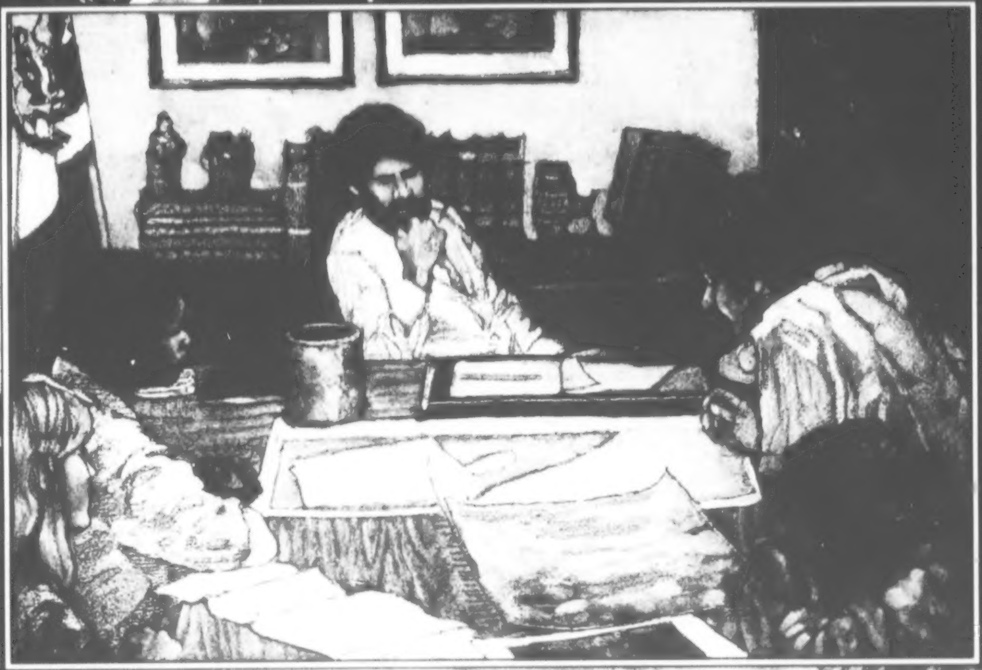
[illegible] large area, Victor agreed, but there were ways to narrow their search. Aerial photographs had revealed the traces of an ancient road that ran south from Cobá towards an area that had never been mapped. Victor felt that their best bet would be to try to follow that road. George Andrews, who knew the region well, could help them find it.

"So will you help us?" Quiché asked.

The director answered that he would alert the police, though there was little for them to go on. He couldn't offer much help, because the institute was so understaffed. But he would give them permission to postpone their work in Tulúm and to use those funds for this search.

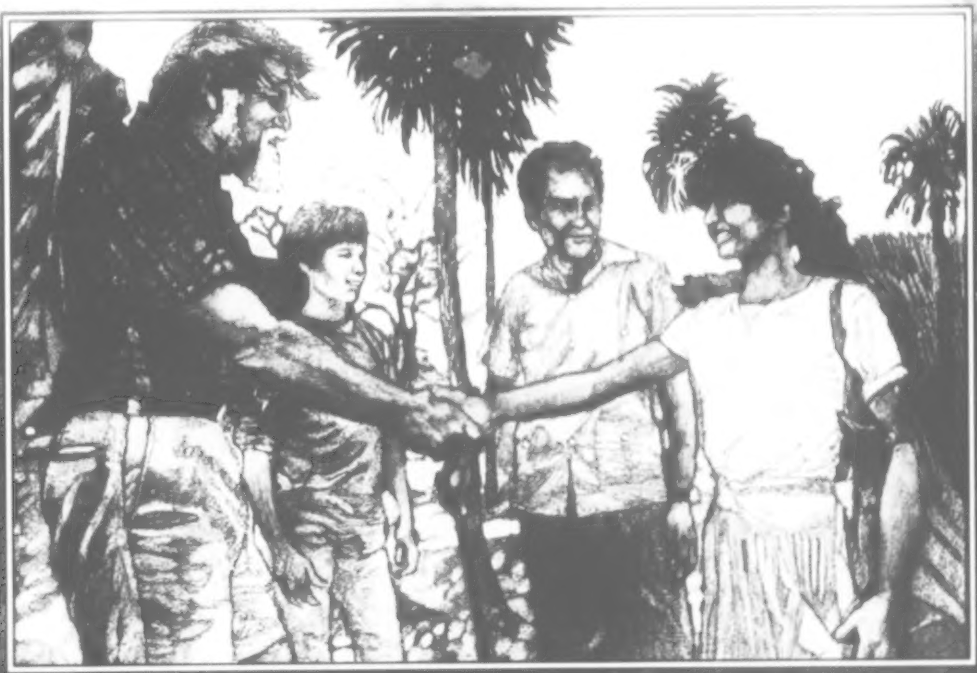
"*¡Fantastico!*" Victor exclaimed. The director suggested that Captain Granville accompany them; they would need a good navigator in the jungle. C.T. liked that idea, since it meant that he would get to go too.

The director rose and wished them luck. He reminded them that looters could be dangerous, and urged them to be careful.



Once we had permission from the INAH director, we were all set, C.T. continued in his journal. *We took Mimi back to Tulúm so Pepper would be in range of our radio.*

Pepper would stay with the boat and relay their messages to INAH. It was sad to leave her behind, but it was vital for them to have a link to the outside world. And she wouldn't be all alone. Segovia's daughter Rosa was going to stay with her. They had become good friends when Pepper had been her dive instructor in Cozumel.



***We started at Cobá**, and we finally met **Jean's husband, George**. He studies the plants that the ancient Maya used.*

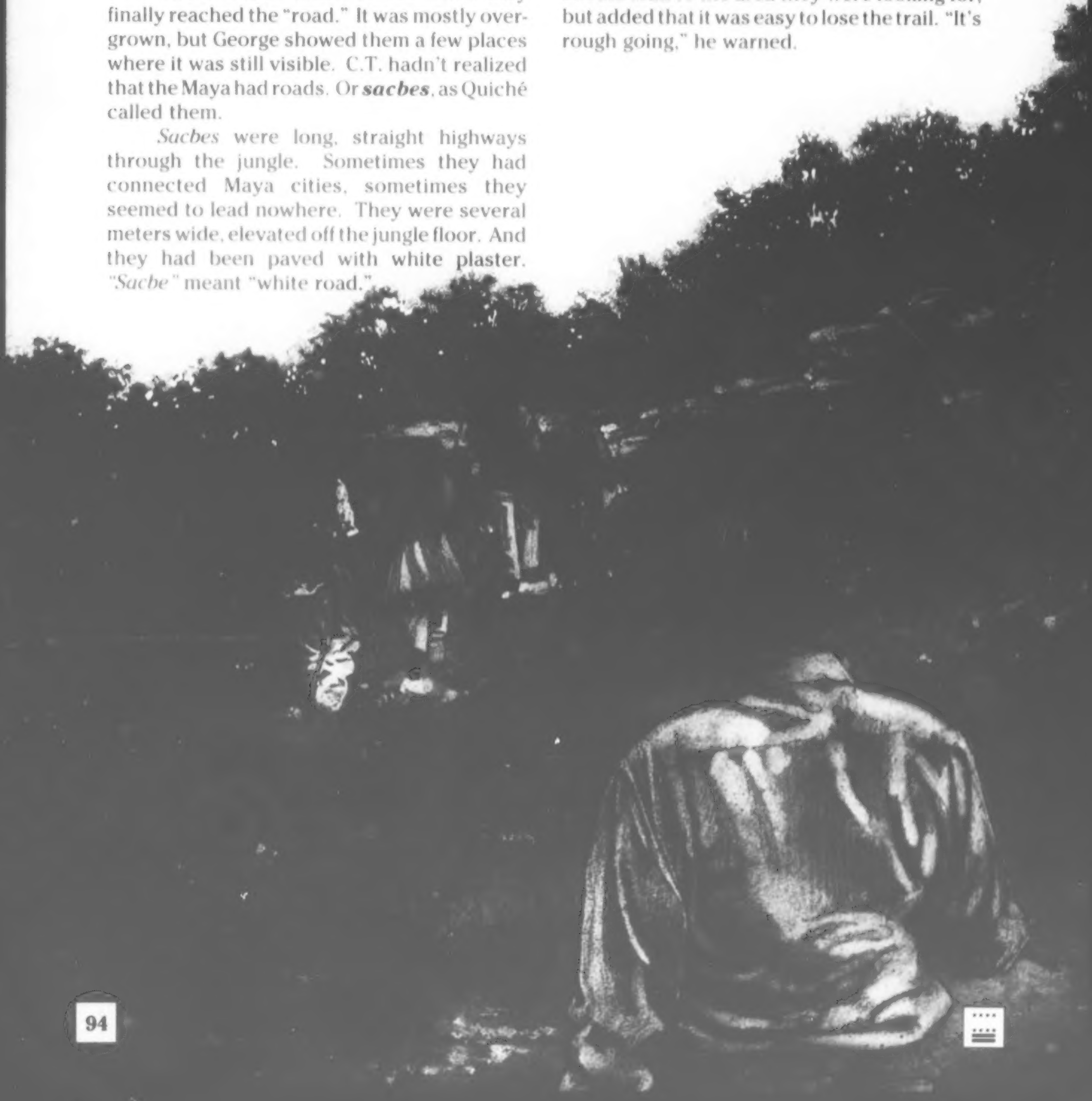
George was English. He stood straight as a pole, and he reminded C.T. of the host of a nature show he used to watch back home. He had spent years prowling this jungle in search of his beloved orchids, and had agreed to lead them to the ancient Maya road they hoped to follow. It wasn't marked on any map; Victor had noticed it on an aerial photograph, just the faintest line, like a scratch on the picture.

There wasn't much to see when they finally reached the "road." It was mostly overgrown, but George showed them a few places where it was still visible. C.T. hadn't realized that the Maya had roads. Or ***sacbes***, as Quiché called them.

Sacbes were long, straight highways through the jungle. Sometimes they had connected Maya cities, sometimes they seemed to lead nowhere. They were several meters wide, elevated off the jungle floor. And they had been paved with white plaster. "*Sacbe*" meant "white road."

The most amazing thing was that the ancient Maya didn't use the wheel. They traveled these roads by foot—just as the *Mimi* crew was doing. Or trying to do. The *sacbe* wasn't much of a road anymore. At best it was just a tiny path, occasionally used by local Maya hunters.

"You're on your own from here," George announced, after they'd gone about three kilometers. He would have enjoyed accompanying them on their search, but his own orchid hunt came first. He told them that the *sacbe* should lead to the area they were looking for, but added that it was easy to lose the trail. "It's rough going," he warned.



"Before you go, George, would [illegible] a look at this?" Captain Granville held out the [illegible] he and C.T. had been using to keep track of their position. "I figure we've gone a little [illegible] three kilometers in a straight line, more or less southeast."

George nodded. It appeared the socbe would lead them in the right direction.

[illegible] that they would need a [illegible] it was found at that time. [illegible] George, [illegible]

[illegible] "Chance" [illegible] had disappeared into the jungle.

Thick jungle was a new experience for C.T. It wasn't like Ohio. It was hot, even though it was almost Christmas. The trees still wore their leaves. And he'd never even seen most of the plants before.

Quiché was a good guide. She showed him a plant called *sac na'b* he could chew on when he got thirsty; the stem was filled with water. She pointed out an army of leaf-cutter ants, each carrying a piece of leaf several times its size. They marched up and down the tree, bringing the leaves to their underground colony. The ants ate the fungus that grew on the leaves.

"They can strip a whole tree bare in one day," Quiché stated.

C.T. wondered if the ants had been doing their job. The vegetation seemed to be closing in on him. The path had petered out a way back, and now the undergrowth was getting thicker and thicker. Soon they were hacking their way through it with **machetes**. He was relieved when they finally decided to call it a day and set up camp.

It was nice to lay in his hammock and look up at the stars. The night sounds were so new and strange, to him at least, that it seemed almost as if he had arrived on another planet. Even the sky looked different.

"Do you like it here?" C.T. asked his grandfather, who was lying in the hammock next to him.

"Can't think of any place I'd rather be," his grandfather answered. "On land, that is."

"Me either," C.T. said. "How come I can't see the Big Dipper?" he asked after a moment.

"It's low on the horizon. It's a different sky here. Different view, that is. You won't find anything in the same place as you do in Ohio."

Ohio. Boy, did that seem far away. He couldn't keep his eyes open a second longer. An animal was howling, deep in the jungle. Must be a...

He was asleep.

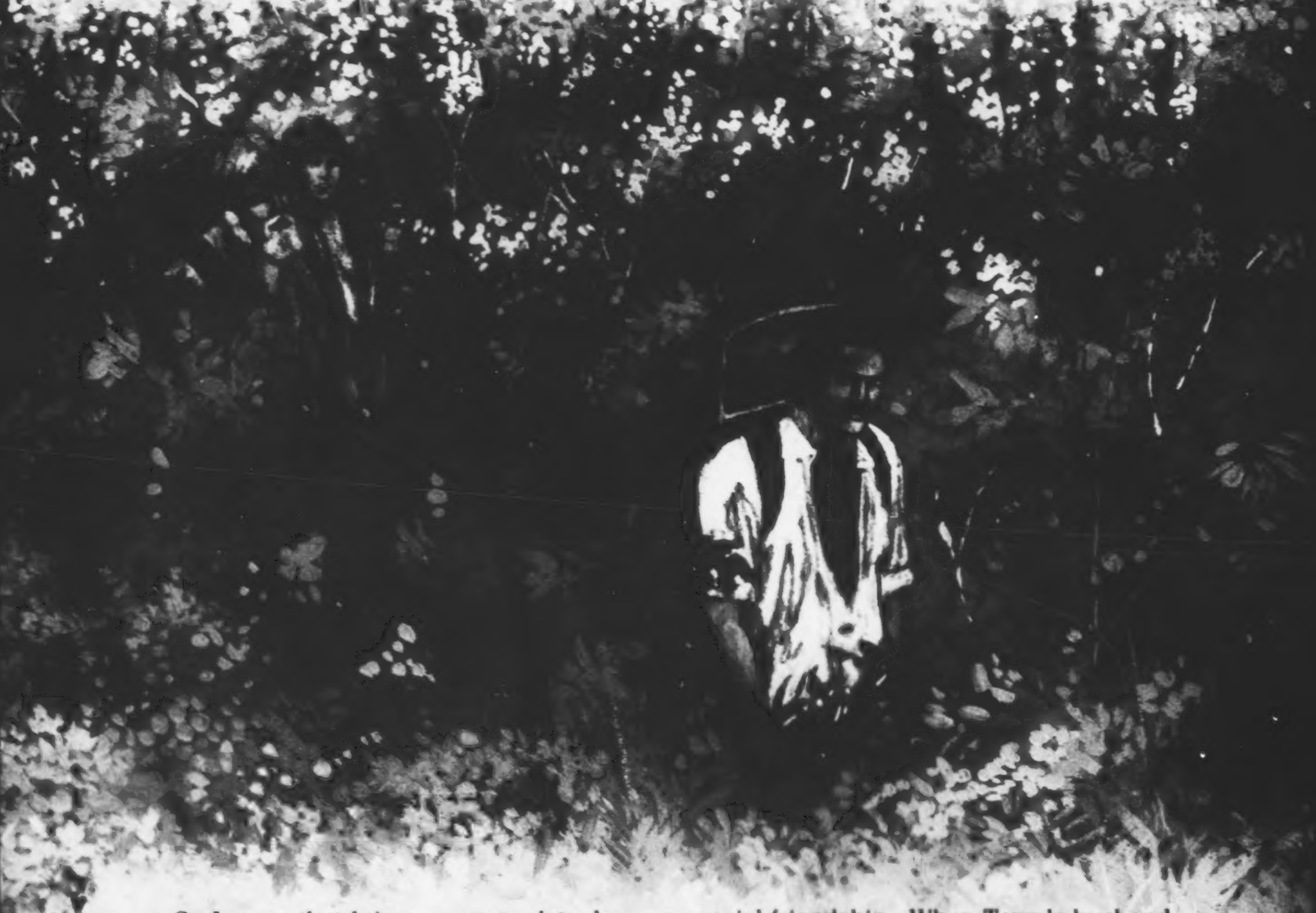
Loud birdsong awoke him the next morning. He sat up in his hammock and started to put on his hightops. Quiché saw him and called out to him. "C.T., wait."

"Wait for what?"

"Shake out your shoes before you put them on," Quiché answered. He'd already put the left one on, so he shook out the right. Something fell out. A big bug. It didn't look friendly.

"That's a scorpion," Quiché informed him, flicking it away with a stick. "It has a poison stinger."

Close call! C.T. thought. He looked in his sneaker and shook it a couple more times before putting it on.



So I guess that brings us up to date, he wrote. *We've been hacking our way through this jungle for a day and a half now. The mosquitoes are terrible. I sure hope that map Grandpa and I are keeping is accurate 'cause we're a long way from anywhere.*

He put down his journal. He wanted to get some rest before their siesta was over. Quiché was up already, strolling around, enjoying the scenery. It felt great to be free of that knapsack for a while.

As Captain Granville set up the radio, Victor told him how he and Terry's husband had been graduate students together and had a special friendship. When Terry's husband died, Victor missed him terribly! But now he and Terry shared that same friendship.

Captain Granville decided to contact *Mimi*. "Vessel *Mimi*, vessel *Mimi*," he said over the radio. "This is U Group. Come back, please."

Quiché had suggested "U Group" as their "handle." Granny had no trouble getting through. Pepper and Rosa were doing fine. They were planning to explore the underwater cave the group had discovered the other day. Terry got on to say hello, then C.T. wanted to talk to Pepper.

Quiche was still off by herself, exploring nearby. She leaned against a tree to watch a centipede climb a branch. Suddenly she felt a sharp sting on her arm. She looked down to find out what it was, and saw a scorpion! She screamed.

"Mom! A scorpion got me!" she hollered. "Mom!!"

Everyone turned.

"Mom!!!"

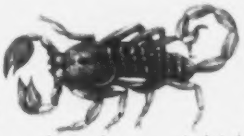
ACTIVITY

Mini-beasts

- There are four million of them in an acre of land. In one square yard of soil, you can find 500 to 2,000 of them.
- They live almost everywhere on earth, from deserts to icebergs, from mountaintops to caves.
- Their legs are jointed and they have six of them.
- Their bodies are divided into three sections: the head, **thorax** and **abdomen**.
- Some chew their food, some suck it up, some lap it up, and others don't eat at all.
- They travel by wriggling, squirming, flying, crawling, hitchhiking, burrowing, swimming underwater or scudding on its surface.
- Most undergo remarkable physical transformations that the best magicians and the best scientists will probably never match.

WHO ARE THEY?

They are the insects, the most common animals on earth. The leaf-cutter ants C.T. and Quiché see are insects. So are butterflies, beetles, dragonflies, mosquitoes and thousands of other six-legged creatures.

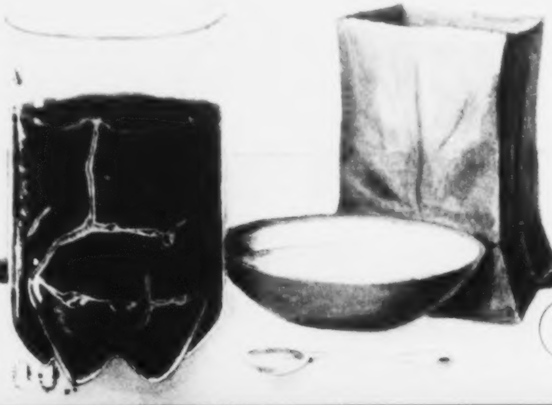


Scorpions, however, are not actually insects. Because they have eight legs and their bodies are divided into only two sections, they are in a class of animals called **arachnids**, not insects. Spiders are also arachnids.

MAKING AN ANT NEST

One easy insect to get to know is the ant. Ant nests are pretty easy to set up and keep.

- You need: a clear 2-liter plastic soda bottle, a short 1-liter plastic soda bottle, a thick rubber band, some clear plastic wrap, a big spoon, a plastic bag, a pin, a small bag of **vermiculite**. (Vermiculite is sold in dime stores and florist shops.)
- Peel the label off the large bottle. Have an adult cut the top off the large bottle, so you can fit the smaller bottle inside it. Fill the space between the two bottles with moist (not wet) vermiculite and pack it down.
- To find ants, take a plastic bag and a big kitchen spoon to a place you've seen ants before. Look under rocks and in sandy places. (Ants are hard to find in cold weather.)
- When you find an anthill, gently scoop around it with the spoon. Try to get ants, eggs and **pupae**. Put them all into the plastic bag. If the ants are very active, putting the bag in a cool place for a few hours will slow them down. Then gently put them in the nest and cover the large bottle tightly with clear plastic wrap and a rubber band. Use the pin to make many air holes in the plastic wrap. To prevent escapes, put your ant nest in a shallow basin of water. (Ants hate to swim.)
- Twice a week feed the ants a little sugar, fruit, bread, or vegetable scraps. Ants eat very little. Don't let the food rot. Use a straw to add a few drops of water twice a week.
- When you're not observing the ants, cover the nest with a small, brown paper bag.



EXPEDITION

A SCORPION TALE

The scorpion that stung Quiché in "The Second Voyage of the *Mimi*" was as harmless as a bee. Quiché got sick because she was allergic to it. But some scorpions in central Mexico can be deadly. Carla Douglin traveled all the way to Cuernavaca, Mexico, to visit Dr. Alejandro Alagón, an expert on scorpions. Dr. Alagón is trying to find a way to protect people from scorpion stings.

Carla's visit started out in the countryside where she helped Alejandro hunt specimens for his research. The landscape was dry and sparse, dotted with cactus.

Dr. Alagón studies scorpion venom to try to make a vaccine against scorpion stings. Carla Douglin helped him collect scorpions in the Mexican countryside.

"What would happen if I did get stung?" Carla wanted to know.

"We would inject you with antivenin that we have in the car," Alejandro assured her. Then he carefully lifted the bark on a fencepost with a screwdriver. "There is room enough for a scorpion to be lying between the post and the bark. You see, there is a scorpion there."

Alejandro deftly picked the scorpion up with a pair of tweezers and put it in the box they had brought.

"This is one of the dangerous ones," Alejandro said. "Remember, all scorpions are poisonous, but not all of them are dangerous."

"Do scorpions always live under the bark?" Carla asked.

"Well, that's one of their favorite places to hide because there are insects that live there and scorpions feed on insects."

At the next post Carla tried her luck with the screwdriver. As she lifted the bark, Alejandro peered under it.

"Don't move. I see one!"

Carla handed him the tweezers and he plucked out another wriggling scorpion!

Carbon dioxide temporarily paralyzes the scorpions so that they can be handled safely. Carla was relieved to know the scorpions would fully recover in about 15 minutes.

Scorpions range in size from one inch to five inches. The smaller they are, the more poisonous they are. Small scorpions must count on their poison or **venom** to paralyze or kill their enemies. Larger scorpions can count on their own strength to fight their enemies.

Carla was surprised to learn that scorpion mothers take good care of their babies.

Alejandro explained, "They take care of the babies for a couple of weeks or so because when the babies are born, they are very, very soft. The mother carries the babies on her back and feeds them directly from her mouth."

"Alejandro," Carla said, "you almost seem to *like* these things."

"I do," Alejandro confessed. "I think they are lovely animals."

Scorpions play a very important **ecological** role. By feeding on insects that eat corn or other sources of food, they are actually helpful to humans.

"You told me if I got stung, I'd get a shot. If you have antivenin, what are you doing in your laboratory?" Carla asked.

"We are trying to make a vaccine against the scorpion venom," Alejandro explained. "The vaccine will work *before* a scorpion stings you. An antivenin works *after* it stings you. A vaccine will protect you for many years, like the polio vaccine."

Carla and Alejandro returned to the lab with about twenty scorpions. During the rainy season, they might have twenty or thirty *thousand* scorpions at the laboratory. To study the venom, Alejandro and his assistant, Rocillo, collect it by "milking" the scorpions. It's not the same as milking a cow. To milk a scorpion, Alejandro and Rocillo pass a weak electric current through its tail.

First, carbon dioxide is put into the box that contains the scorpions. The carbon dioxide pushes out the oxygen. The lack of oxygen paralyzes the scorpions, making them a lot easier to handle.

Alejandro dropped a few pieces of dry ice into a **graduated cylinder** full of water. Dry ice is frozen carbon dioxide. When you put it in water, it turns back into a gas. Rocillo covered the cylinder and all the carbon dioxide gas was directed into the scorpion box through a rubber tube. The carbon dioxide is heavier than air so it remains in the box.

"Will the carbon dioxide kill them?" Carla asked, concerned.

"No," Alejandro assured her. "In about fifteen minutes they will completely recover from the **anesthesia**, so don't worry."

Alejandro blew the carbon dioxide out of the box. All twenty scorpions were lying motionless at the bottom of the box.

Rocillo lifted a scorpion with a tweezer and rested it on a small padded block. She touched the scorpion's stinger with an **electrode**. As the stinger contracted, a tiny drop of venom appeared on the tip of the tail.

"Is that enough to kill you?" Carla asked.

"It might be enough to kill a child, but probably not an adult," Alejandro said.

In this part of Mexico nearly a thousand people die of scorpion stings each year, and most of them are small children.

Alejandro explained that scorpions are not insects. They have eight legs and belong with the spiders to the class of animals called arachnids.

"They look a lot like lobsters," Carla said.

"In fact, a friend of mine ate one once," Alejandro said. "He cooked it. He told me that scorpions taste just like shrimps or lobsters."

"He ate one?" Carla looked disgusted. "Wouldn't the poison kill him?"

"He just removed the tip of the tail—the **telson**," said Alejandro. "That's the place where the poisonous gland is. The rest of the scorpion is harmless."

Carla described how they filmed the scorpion scene in "The Second Voyage of the *Mimi*." A scorpion breeder took the stinger off a scorpion. Then they filmed the harmless scorpion crawling on Carla's arm.

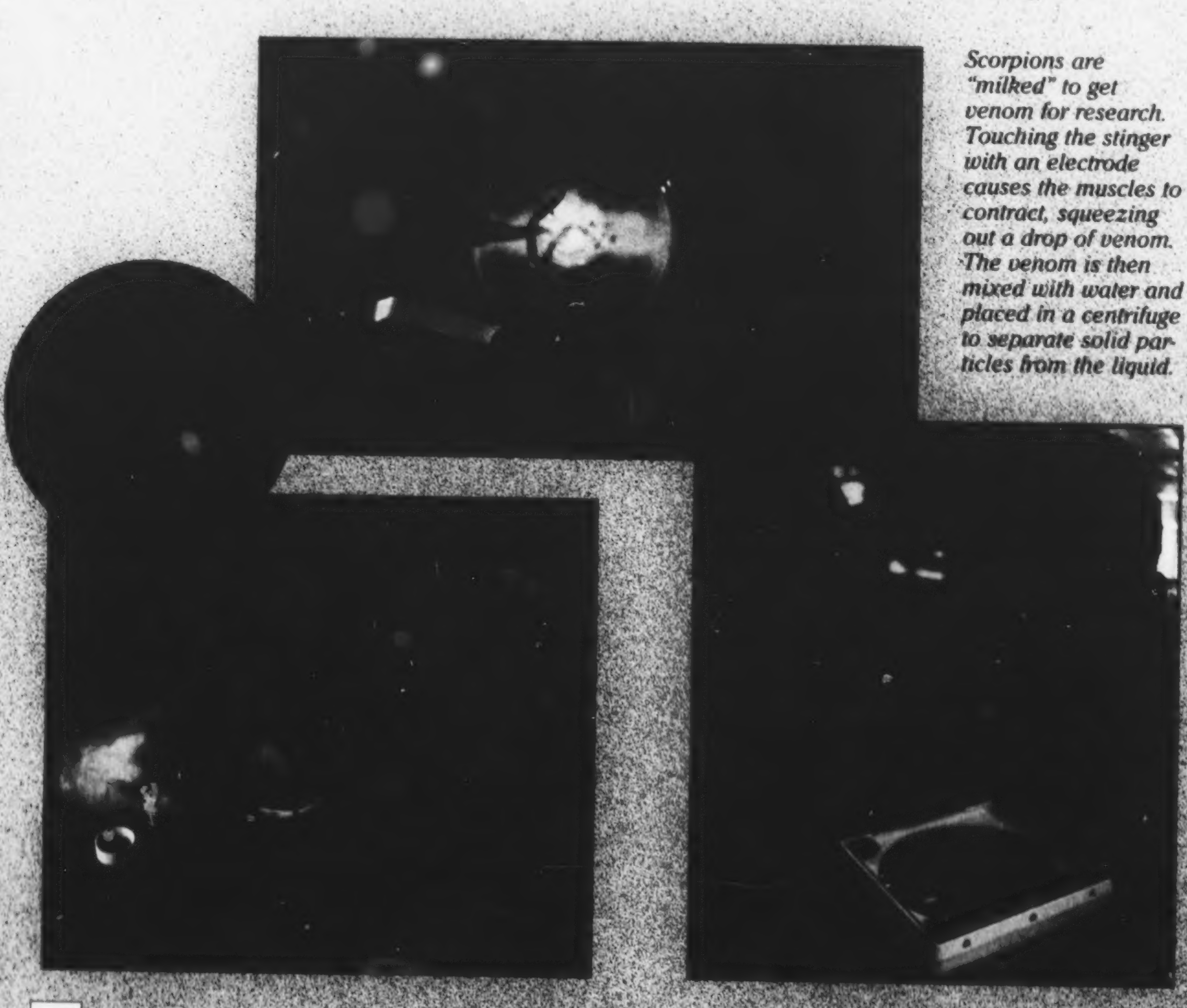
Now, Carla tried milking a scorpion. She touched the electrode to the scorpion's telson. A small drop of venom appeared.

"Hey, it worked!" Carla exclaimed.

The electricity makes the muscles around the telson squeeze the venom out. It doesn't seem to hurt the scorpions. At least they recovered right away.

Carla was amazed at how little venom they had collected when they were finished. She learned it takes two to three thousand scorpions to make just one **gram** of poison.

Next, Rocillo used water to wash the venom out of the container—called a **petri dish**—and collected the **solution** in small vials. At this point it still wasn't pure venom mixed in water, though. There were lots of little particles in it that made it look cloudy.



Scorpions are "milked" to get venom for research. Touching the stinger with an electrode causes the muscles to contract, squeezing out a drop of venom. The venom is then mixed with water and placed in a centrifuge to separate solid particles from the liquid.

Alejandro also studies Gila monsters, venomous lizards from the Gila Desert in Arizona. His work with venomous animals of all kinds may someday save many lives.

A machine called a **centrifuge** is used to get the solids out of the venom. It spins the vials around at high speed. That causes the particles in the liquid to fly out to the ends—sort of like your clothes fly out against the sides of a washing machine when it spins.

It only took a few seconds. When the machine stopped, all the particles were at the bottom, and the liquid was clear.

"And the clear part is the part we want," Carla thought aloud. "It looks just like water, but it's still poisonous, right?"

"Oh, very poisonous," said Alejandro.

The clear liquid is actually made up of many different kinds of poison—called **toxins**—in each drop of venom. In fact, the venom contains more than twenty different poisons.

Scorpions need specific toxins for each of the different animals they feed on—such as insects, arachnids, worms—and for different kinds of enemies.

Before a vaccine can be made, the different toxins have to be separated out so their effects on humans can be studied. The first step is to run the venom through a long column filled with a special kind of gel or jelly. The toxins with the heaviest **molecules** fall to the bottom faster and come out first. The toxins with lighter molecules follow.

This important work might take many more years, but someday it may save many thousands of lives.

Alejandro studies venomous animals of all kinds. He showed Carla a pair of Gila monsters named Peter and Rosita.

"This little fellow here is the real **Gila monster** because it comes from the Gila Desert in Arizona."

Carla gingerly stroked the scaly colorful lizard as Alejandro held it. Both smiled.

Carla wasn't sure she'd ever like scorpions or Gila monsters quite as much as Alejandro does. But who knows? Learning more about them could be the first step in that direction.

SCORPIOLOGY

Are the following statements true or false? For help, re-read Expedition 8, "A Scorpion Tale."

1. A 1-inch scorpion is more poisonous than a 5-inch scorpion.
2. Scorpions feed on humans and other mammals.
3. Scorpions make good mothers.
4. The scorpion injects poison through its claw-like pincers.
5. Antivenin is the opposite of uncle-venin.
6. A Gila monster is a large slimy monster that lives in a swamp.
7. Scorpions have udders to give milk to their young.
8. Carla could have been killed by the scorpion used in the "sting" scene in Episode 8.
9. Scorpions are actually helpful to people.
10. A vaccine protects you before you're stung; an antivenin protects you after you're stung.

Answers: 1. True; 2. False; 3. True; 4. False; 5. False; 6. False; 7. False; 8. False; 9. True; 10. True.

EPISODE

"A FRIENDLY VILLAGE"

Quiché stared at the spot on her arm where the scorpion had stung her. "Help, Mom!" she called again. She could see the scorpion on the ground where it had landed when she brushed it off her arm.

"Are you sure it was a scorpion?" Victor asked when he and Terry reached her. Yes, she told them, she had seen it clearly.

Terry put her arm around her, and lead her to a hammock. Victor dashed over to his knapsack and pulled out the first aid kit.

Pepper's voice came over the radio. "Hey C.T., what's going on there?" He had forgotten all about her. He told her what had happened to Quiché, then Granny got on and asked her to stand by in case they needed help.

"Ow, ouch!" Quiché muttered. It hurt! "Am I going to be O.K.? I'm not going to die, am I?" she asked, starting to get scared.

"No, sweetheart, you're not going to die," her mother reassured her. She stroked Quiché's forehead. "Now just calm down."

Calm down? She could see Victor approaching with a needle in his hand. "I thought I was going to be *O.K.*," she groaned.

"You are, kiddo. I am more worried about that poor scorpion that bit you. They hate the taste of *gringa*," Victor joked.

"They don't bite," Quiché corrected him, "they *sting*."

Victor explained that he had to give her a shot of **cortisone**, in case she had an allergic reaction. Quiché said she *was* allergic—to needles. He didn't buy it. She felt the sharp jab of the needle.

C.T. was about thirty yards away when he heard the "ouch!" He was going to look for firewood, because now they would have to spend the night there. Poor Quiché. He kept thinking about that scorpion in his sneaker.

"That didn't hurt so much," Victor said.

"Didn't hurt who?" Quiché said.

Victor grinned. "Me, who else?"

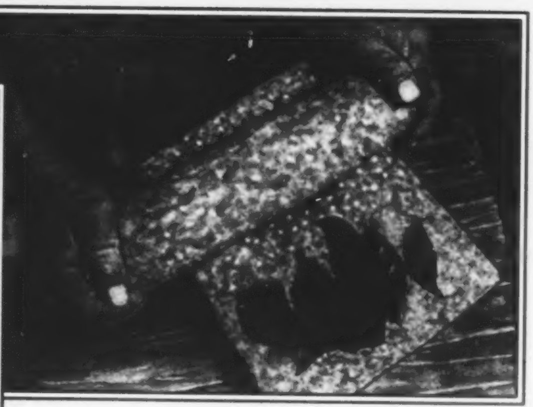
Quiché was beginning to feel weak. Terry told her she would probably get a little sick. "What about the lost city?" Quiché said.

"It hasn't gone anywhere for fifteen hundred years," Victor said. "I'm sure it will wait another day."

Soon she fell asleep. Victor was worried. If she *was* allergic, he told Terry, it could be bad. But it was too late to go anywhere.

C.T. was gathering firewood when he saw a small figure through the brush. It was a young Maya boy, dwarfed by the bundle of wood he carried on his back by means of a sling that looped around his forehead. They stared at each other.

"Hi," C.T. said, finally. No response. The boy just stood there, wide-eyed. C.T. tried again. "*¿Hola?*"



Terry sat next to the hammock, cradling her daughter's head. Quiché's forehead was beaded with sweat. "How're you feeling now, honey?" Terry asked. Quiché looked up, but didn't say anything.

"This is the doctor for the village," Victor told her. "He is going to make you feel better. *¿Entiendes?*"

"*Sí*," Quiché answered weakly.

The boy led them to his village. Granny and Victor carried the homemade stretcher with Quiché in it. Terry walked along next to the stretcher, carrying Quiché's knapsack as well as her own. C.T. brought up the rear, a machete in each hand.

It was a small village, just a cluster of small round houses with thatched roofs. A dog barked. Children watched them in silence. A couple pigs foraged around in the shade of a big tree.

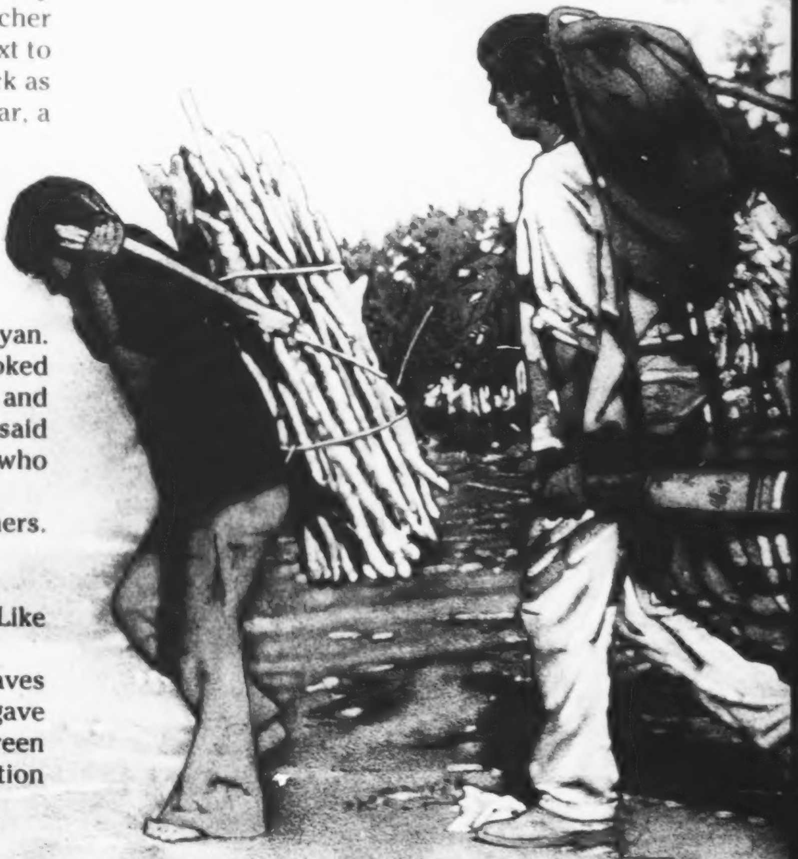
Victor spoke to a young man in Mayan. The man went over to the stretcher and looked at Quiché. There was sweat on her brow, and her eyes were closed. She moaned. He said something to Victor, then spoke to a boy, who ran off towards one of the houses.

"It's all right," Victor told the others. "We're taking her to the ***curandero***."

"What's a *curandero*?" C.T. asked.

"It's like a doctor," Victor replied. "Like a medicine man."

The *curandero* ground up some leaves with a rolling pin made of stone. He gave Quiché a leaf to chew on, then applied a green **poultice** to the wound. It was a combination of two local plants.



The villagers invited them to stay in a house they kept for visitors. They lit a fire and strung up the hammocks. Granny asked Victor if he really believed in herbal medicine.

"The Maya have been using these plants for a few thousand years," Victor replied.

"They use plants for medicine?" C.T. asked.

"Sure, mostly," Victor said. "Our so-called modern doctors have learned a thing or two from folks like this. And anyhow, the more you believe in a medicine, the better it works."

They were relieved when Terry returned from the *curandero's* house and said that Quiché was going to be all right. "Somebody's medicine, yours or the *curandero's*, did the trick," she said to Victor, smiling.

"I told you she was too much for any scorpion," Victor said. They all felt better now that they knew Quiché was on the road to recovery.

Terry thanked them and said she was going back to stay with her daughter. "Where's my queen-size extra firm?" she joked. Victor handed her a small bundle of string: her hammock.

C.T. lay in his hammock, thinking about all that had happened. He hadn't thought about the lost city for hours. Now they started to talk about it again. Granny wondered whether the villagers could help them find it.

"If it's anywhere around here," Victor said, sleepily, "they should know. If there *is* such a place."

C.T. tried to picture the lost city in his mind, but his weary body had other plans: sleep.

Quiché woke him in the morning. She was all better and feeling cheery. Everyone else had been up for a while. "I thought all you farmers got up early," she teased, as he put on his sneakers. He did it very carefully.

Terry and Victor were meeting with the head man, Don Esteban, and his son Juan, who had helped them the day before.

"Hax dios botic," Terry said—Mayan for "Thank you." Don Esteban said that he too was thankful that Quiché was better.

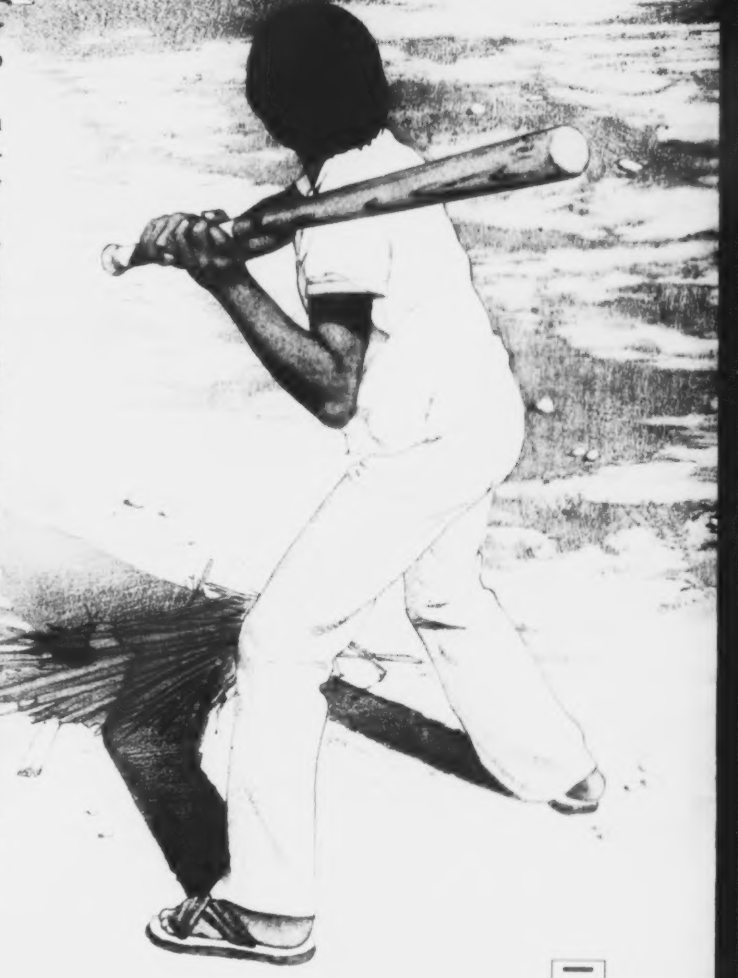
After that they spoke in English, with Juan translating. It was a polite and formal exchange. Terry and Victor explained that they were archaeologists looking for a lost city. The head man became withdrawn when they asked if he knew of any ruins in the area. He got up, invited them to join him for a meal in the afternoon, and quickly retired to his house.

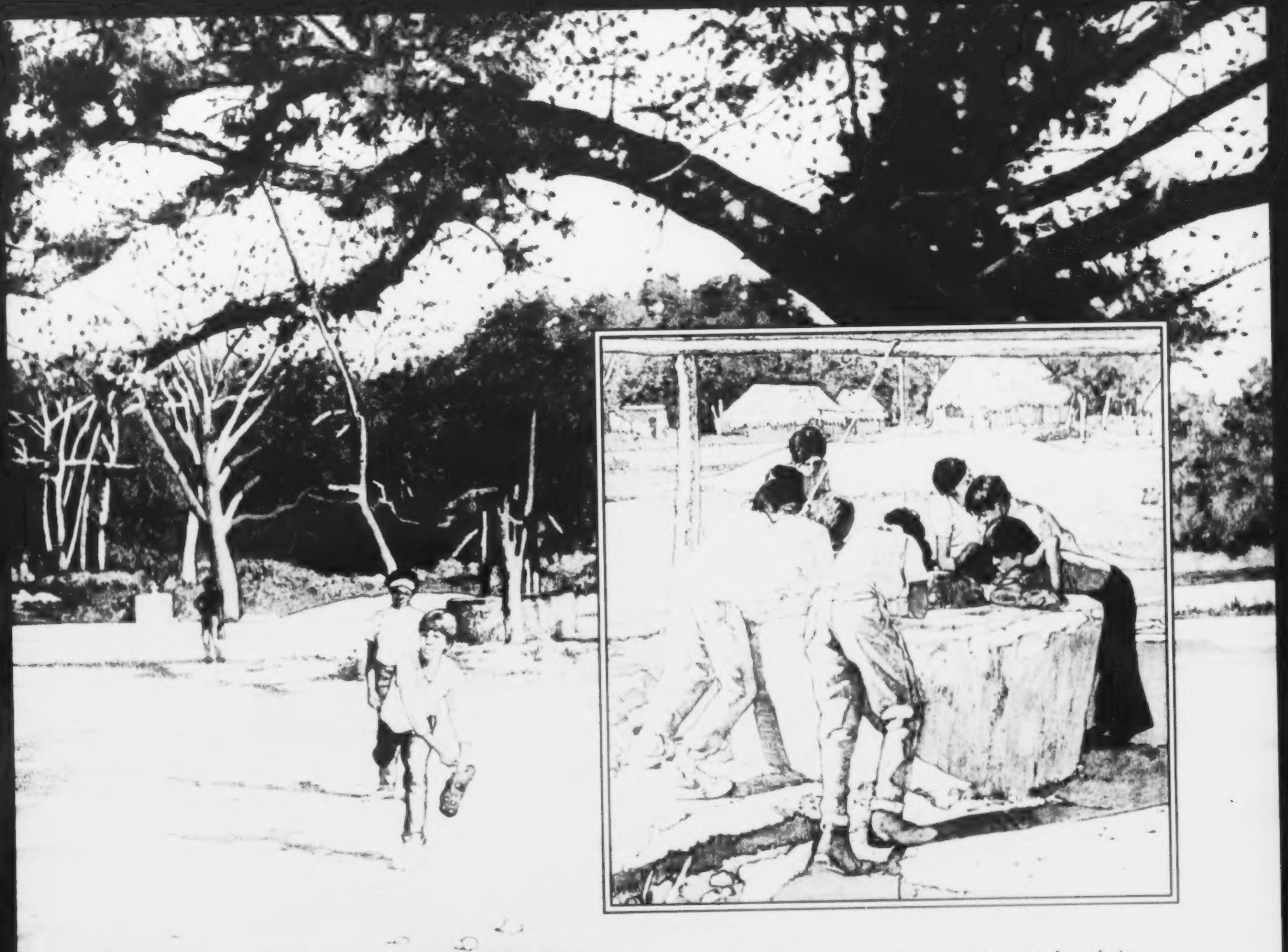
Juan suggested they were thinking of Cobá. But Terry and Victor said they'd just come from Cobá. "I wish I could help you," Juan said, evasively. Terry decided it was best not to press him. Something didn't seem right.

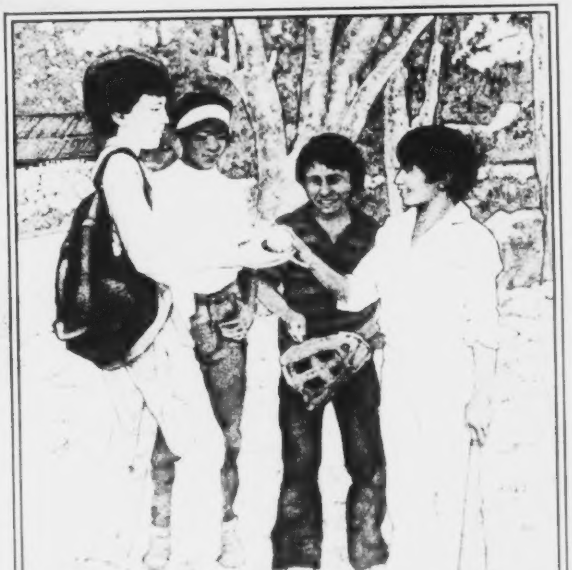
They told Captain Granville about their strange meeting. "I hesitate to say this, but could they be your looters?" he asked. Terry looked doubtful, but said it was possible. She pointed out that you could argue that they rightly *owned* their ancestors' things.

"I can't believe these people would steal," Victor said. "But, something smells like fish."

C.T. and Quiché were playing baseball with the village kids. The field was at the center of town. You had to run over a big mound of dirt to get from first to second. A huge old tree sat in the middle of the outfield.







C.T. felt great. It was nice to be doing something familiar for a change. When it was his turn at bat, he got a good pitch and walloped it. It hit a branch of the tree, bounced and fell, right down the village well. Talk about hitting it out of the park!

Quiché translated for him when he apologized to the kids for losing their ball. "That Maya sure sounds a lot like Spanish," he said, when she was through. It *was* Spanish, she said. The kids learned it in school.

"Am I the only person in the world who only knows one language?" C.T. muttered.

He remembered that he had a baseball in his pack, and gave it to one of the guys. It was sort of a good luck charm, but so far they hadn't been real lucky. Maybe it would bring them some luck if he gave it away.

It did. That afternoon they sat in a big circle with the villagers, eating a traditional Maya meal. The guy C.T. had given the ball to tapped him on the shoulder and pulled him from the group. Quiché joined them.

C.T.'s new friend handed him a little bundle wrapped in cloth. *"Esto es un regalo para ti,"* he said.

"He wants to give you a present," Quiché translated. "I think it's because you gave him the baseball."

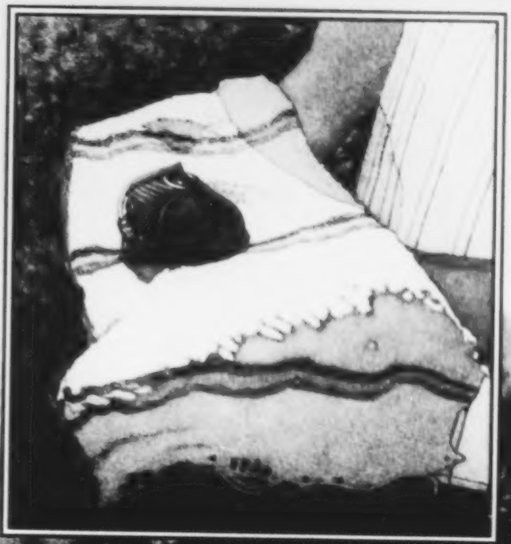
C.T. unfolded the cloth. He couldn't believe his eyes. There lay a little jade head, beautifully carved. It was green and smooth as glass, and C.T. figured it was probably real. *"Muchas gracias,"* he stammered.

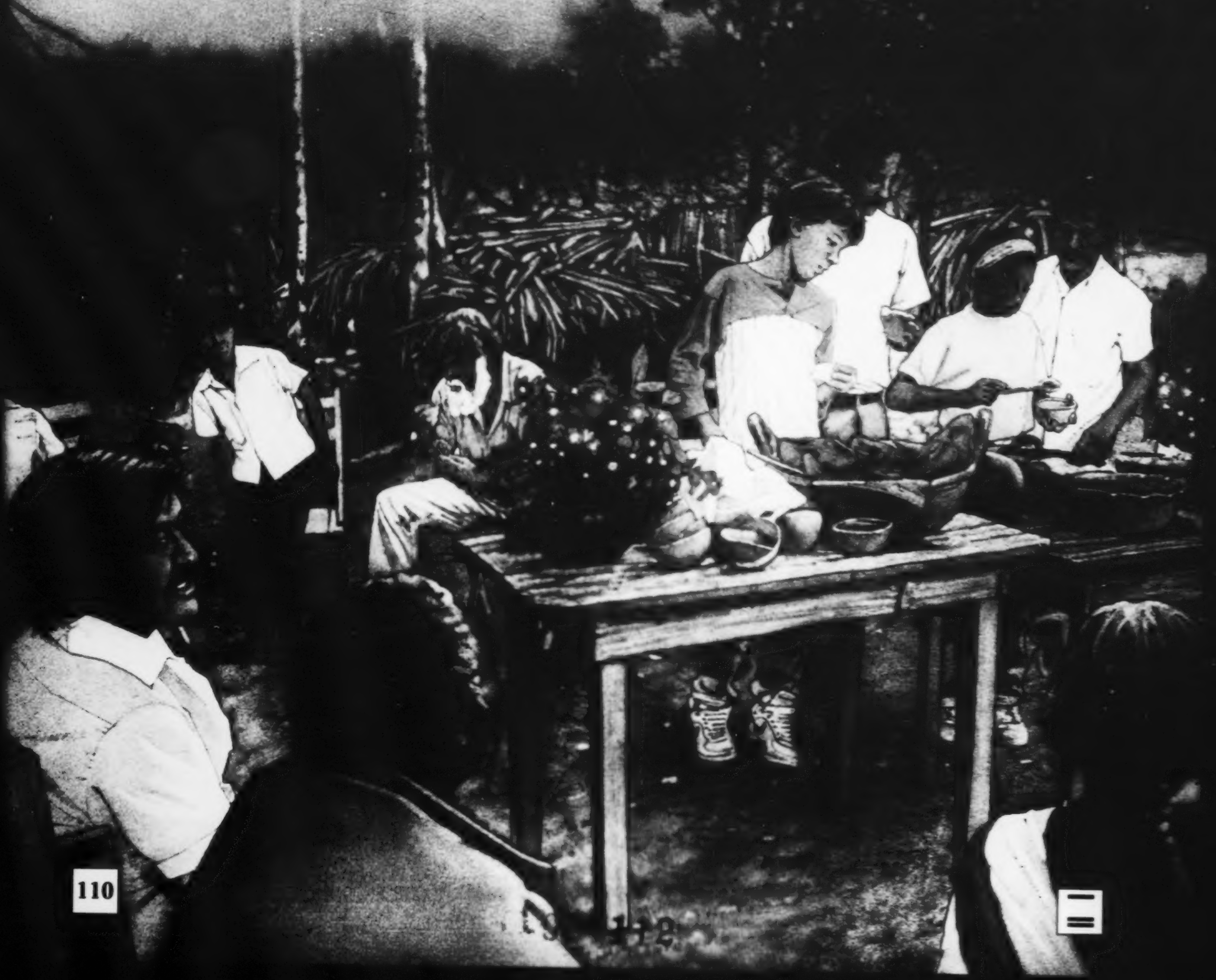
He took it over to show to Victor and Terry. They stared at the jade figurine, then looked at each other.

"Is it real?" C.T. asked.

"It's real," Terry answered with conviction, her voice low. "And it has to have come from a burial site."

Juan had noticed them examining the jade gift. He was standing at the table, filling a tortilla. His face looked grim.





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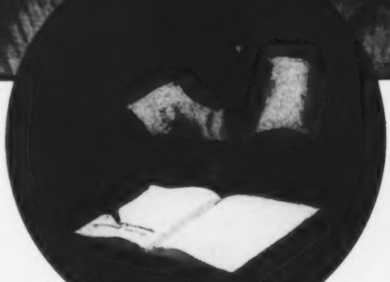
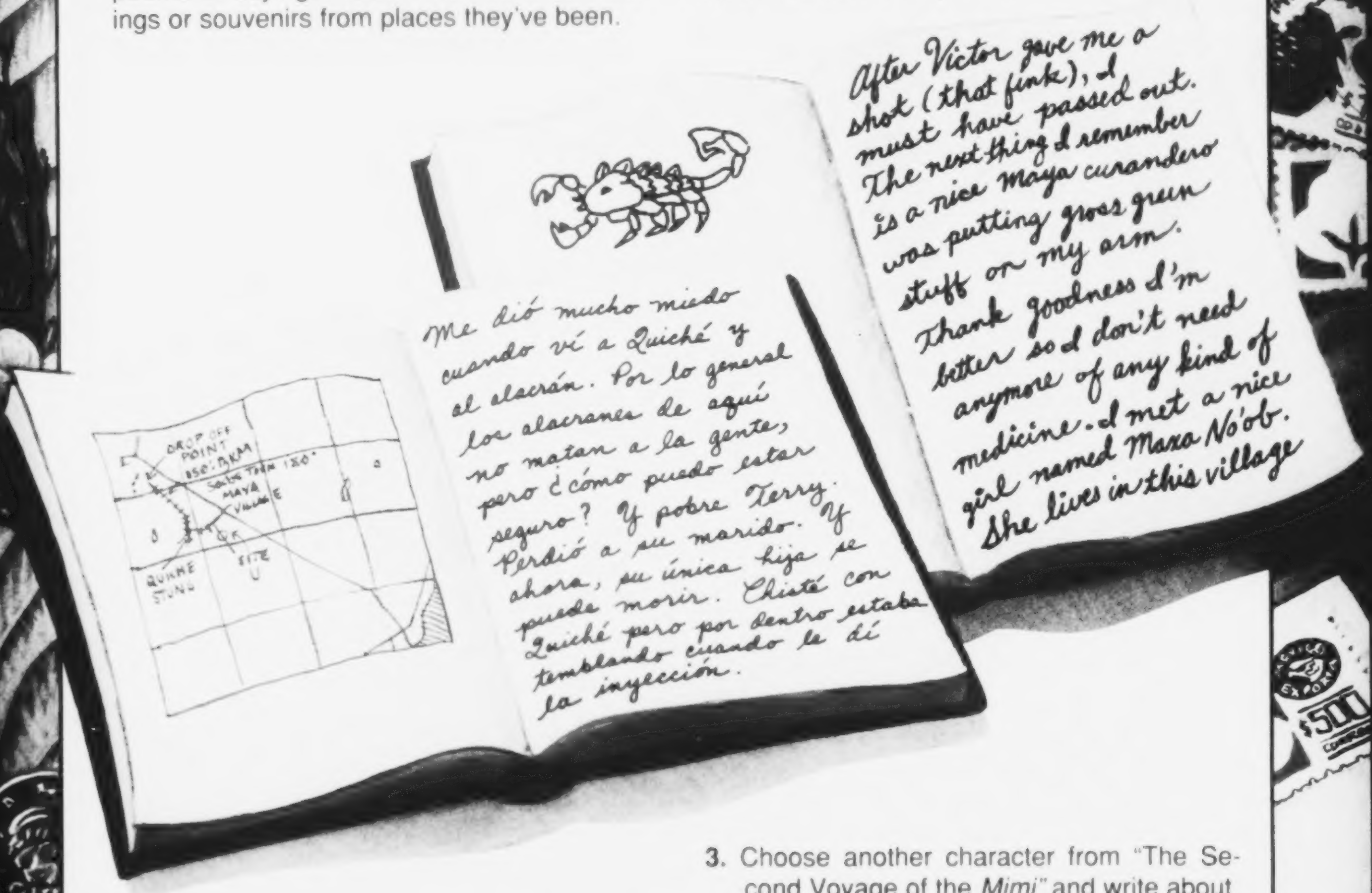


Dear Diary

Keeping a journal really helps you remember things that go on in your life. Many people write about things that happen to them, thoughts, feelings, dreams, hopes, favorite poems or sayings. Some folks include drawings or souvenirs from places they've been.

In "The Second Voyage of the *Mimi*," C.T. writes in his journal almost every day. If some of the other *"Mimi"* characters kept journals, they might be like this. (You can probably guess which characters they are.)



Me dió mucho miedo
cuando ví a Quiché y
al alacrán. Por lo general
los alacranes de aquí
no matan a la gente,
pero ¿cómo puedo estar
seguro? Y pobre Terry.
Perdió a su marido. Y
ahora, su única hija se
puede morir. Chisté con
Quiché pero por dentro estaba
temblando cuando le dí
la inyección.

After Victor gave me a
shot (that fink), I
must have passed out.
The next thing I remember
is a nice Maya curandero
was putting gross green
stuff on my arm.
Thank goodness I'm
better so I don't need
anymore of any kind of
medicine. I met a nice
girl named Maxa No'ob.
She lives in this village

Here are some journal writing ideas:

1. Complete one of these journal entries.
2. Write your own journal entry about what happened in your life today.
3. Choose another character from "The Second Voyage of the *Mimi*" and write about what happened in Episode 9 from her or his point of view.
4. Keep a journal for one of the characters for the rest of "The Second Voyage of the *Mimi*."
5. Keep your own journal, starting now. Try to write in it every day.

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EXPEDITION

CURANDERA

When Quiché gets stung by a scorpion in "The Second Voyage of the *Mimi*," she is treated by a *curandero*, a Maya medicine man who uses medicine made from plants. Quiché might have gotten better from that, or because of the shot Victor gave her, or she might have gotten better all by herself. But it is true that plants can be medicinal. About half of all the drugs in our modern pharmacies are made from chemicals first discovered in plants.

Edel Bye is a **botanist** who studies traditional plant cures used by the Indians in central Mexico. Edel wants to find out which plant cures work and why they do. Carla Douglin went to central Mexico to meet her.

Before the Spaniards came, this part of Mexico was inhabited by the Aztec Indians, not by the Maya. Edel and Carla headed for the mountains outside Mexico City to meet an Indian healer, or *curandera*, who is descended from the ancient Aztecs. "We are going to meet doña Sebastiana. People come from all over Mexico to be treated by her," Edel told Carla.

They passed many gardens along the way. Edel told Carla that archaeologists have found traces of ancient gardens in this area—gardens where the Aztecs grew medicinal plants.

They pulled up on a dusty road and knocked on the door of a small, white house. Doña Sebastiana greeted them warmly. She spoke Spanish and Edel translated for Carla.

Doña Sebastiana treats people for many different ailments. She usually makes a tea to be drunk or a paste that's rubbed on. Sometimes she gives her patients a "sweat bath" in one of the small mud huts in her back yard.

She brings different plants inside the hut along with the patient. The kinds of plants used

Doña Sebastiana is a real curandera. She showed Edel Bye and Carla Douglin a "sweat hut," one of the traditional methods she uses to treat illnesses.

Collecting medicinal plants.

depend on the illness. Water is thrown onto stones that have been heated in a fire. The hut fills with fragrant vapor. The people inside sweat a lot as they inhale the delicious vapor, and doña Sebastiana feels this helps heal them.

Doña Sebastiana and her daughter both go inside the hut with the patients. Doña Sebastiana massages people and directs the treatment. Her daughter helps her. That's how the daughter learns to be a *curandera*.

Many cultures, including the Maya, have used sweat baths for centuries. People in the United States and in Europe also think steam baths and **saunas** are healthful.

During Carla's visit, someone came to doña Sebastiana for help. He had an eye irritation. Doña Sebastiana showed him how to soak a certain kind of rose blossom in water and bathe his eye in it. This is the kind of treatment Edel and her colleagues might test scientifically later to see if there are chemicals in the flower that can soothe irritations.

People wouldn't keep coming to see doña Sebastiana if she didn't help them. But even our doctors know that sick people often get better just by believing they will. That's why it's important for Edel to try to learn if the plant cures really work and what is in them that makes them work.

Doña Sebastiana invited Edel and Carla to go with her to collect some plants. It was supposed to be the rainy season, but the rains were late. It was so dry outside that the van disappeared into a cloud of dust as they headed up a hill. Though there wasn't that much growing, doña Sebastiana was able to find some plants she would use for medicine. She pointed out a **lichen** that is supposed to soothe cramps and another plant that is good for gas.

When doña Sebastiana pointed out a plant Edel was not familiar with, Edel collected a sample to take back to the lab. There, she will identify it and have it analyzed. She is careful not to take all of the plant so it can keep growing. The people of the village consider the forest above their town to be sacred. That's partly because it is a source of so many medicinal plants. They protect the forest from harm by loggers and developers.

On the way back to Mexico City, Carla asked, "Where do the *curanderas* learn how to use these plants?"

"It's a tradition," Edel explained. "The mother teaches the daughter and the grandmother teaches the granddaughter. You don't learn how to do it in school. It's only in the family," she said.

Next Edel took Carla to the *Mercado Sonora*, the largest medicinal herb market in Mexico. The huge indoor market was filled with dozens of sellers. Each had a booth full of brilliantly colored flowers and herbs. A group of musicians played to entertain both sellers and shoppers. Healers and ordinary people come to this market to find cures for everything from heart disease to hair loss.

Edel knew many of the sellers there. She stopped and asked one of them for something to cure Carla's chest cold. The flowers of the beautiful vine, bougainvillaea, were recommended for Carla's cough. The flowers must be boiled into a tea. Another plant was suggested to soothe the throat.

Samples of plants collected during the visit with doña Sebastiana will be analyzed in the laboratory.

At the Mercado Sonora.

"Is she a *curandera*?" Carla asked.

"No. She heals her family only," replied Edel. "She doesn't take money for healing other people."

Edel is trying to learn about the culture of the Indians, as well as their medicinal plants. To learn exactly how the cures work, she has to do a careful scientific study. This is done at the laboratory of Dr. Xavier Lozoya. His lab specializes in the study of traditional medicines. He offered to show Carla how he works with the plants. The tour began in the library. The knowledge of traditional medicine has been passed down for centuries. So Dr. Lozoya studies the past as well as the present.

He explained, "When the Spaniards came to America, they asked a lot about the medicinal plants of the people in Mexico. So, books were prepared after the conquest of Mexico with the help of the Indians of those days." He showed Carla enormous volumes with elegant hand-written information and many beautiful color illustrations of plants. The writing was all in Spanish.

"These plants are still in use by our people in Mexico today. Now we're studying them with modern science and technology," Dr. Lozoya continued.

He gave Carla an example. "We find a plant here. We read all the information the Aztecs had about it. Then we go to the countryside to collect the plant to prepare the same products as the Aztecs did. Then we take those products to the laboratory and study how they act in animals and humans to cure them."

This kind of research has led to many medical discoveries. A common plant called foxglove was used for centuries to treat heart problems. It became the source of an important heart medicine called Digitalis. The main chemical in aspirin was found in the bark of the common willow tree. Before modern medicine "discovered" it, so-called "primitive" healers had long used it to treat pain and fever.

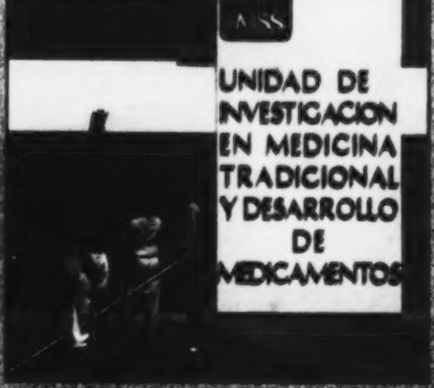
Dr. Lozoya's work shows that we can still learn from ancient people and from people we might not think of as scientifically advanced.

"There must still be a lot of plants we don't know about," Carla said.

Dr. Lozoya said that ninety percent of the plants have still not been studied by science. "So there is a lot of work to be done in the future," he said.

Carla's next stop was the laboratory where the plants that Edel and Dr. Lozoya collect are dried and then soaked in water or other liquids. These teas are then separated into all their different chemicals by running them through a column filled with gel. That part reminded Carla of Dr. Alagón's lab. The same method was used to separate the chemicals in scorpion poison.

Dr. Xavier Lozoya's laboratory specializes in the study of traditional medicines.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UNIDAD DE INVESTIGACION EN MEDICINA TRADICIONAL Y DESARROLLO DE MEDICAMENTOS

In Dr. Lozoya's lab, teas are made from medicinal plants. The teas are separated into different chemicals which are tested to see how they work.

Some of our worst diseases might someday be conquered by a flower!

(Speaking of poison, it's not a good idea to eat or drink tea made from just any plant. Some of them are *very* poisonous.)

After the chemicals are separated, they are tested in different animals to find out which are the active compounds and how they work.

Carla had one last question for Dr. Lozoya. "When you're sick, do you ever use traditional medicine?"

"Sometimes, yes," he answered. "Particularly when I have common disorders like cough or diarrhea. There are very good traditional remedies. For other diseases you must use modern medicine. Both are very useful," he continued. "We have certainly developed some very good medicines in the last hundred years. But in many respects we are using the same medicine that people developed several centuries ago."

PLANT POWER

- Many important medicines come from plants that are poisonous to people. They may be poisonous if eaten whole, but if diluted and properly prepared, they can save lives.
- Without plants, there would be no food on earth. Even the lion who eats an antelope is eating plants "second-hand."
- Over half the medicines used today originally came from plants.
- Thousands of species of plants become extinct every year.
- Only 1% of the plants in the world have been studied to see if they might be new sources of food or medicine. Maybe there are plants that could cure the common cold or even cancer that will be extinct before anyone knows it.

Can you think of examples of foods that are roots, stems, seeds, flowers, or leaves?

Plants provide much more than food. Name 20 things you use that come from plants.

31117

EPISODE 10

DISCOVERIES

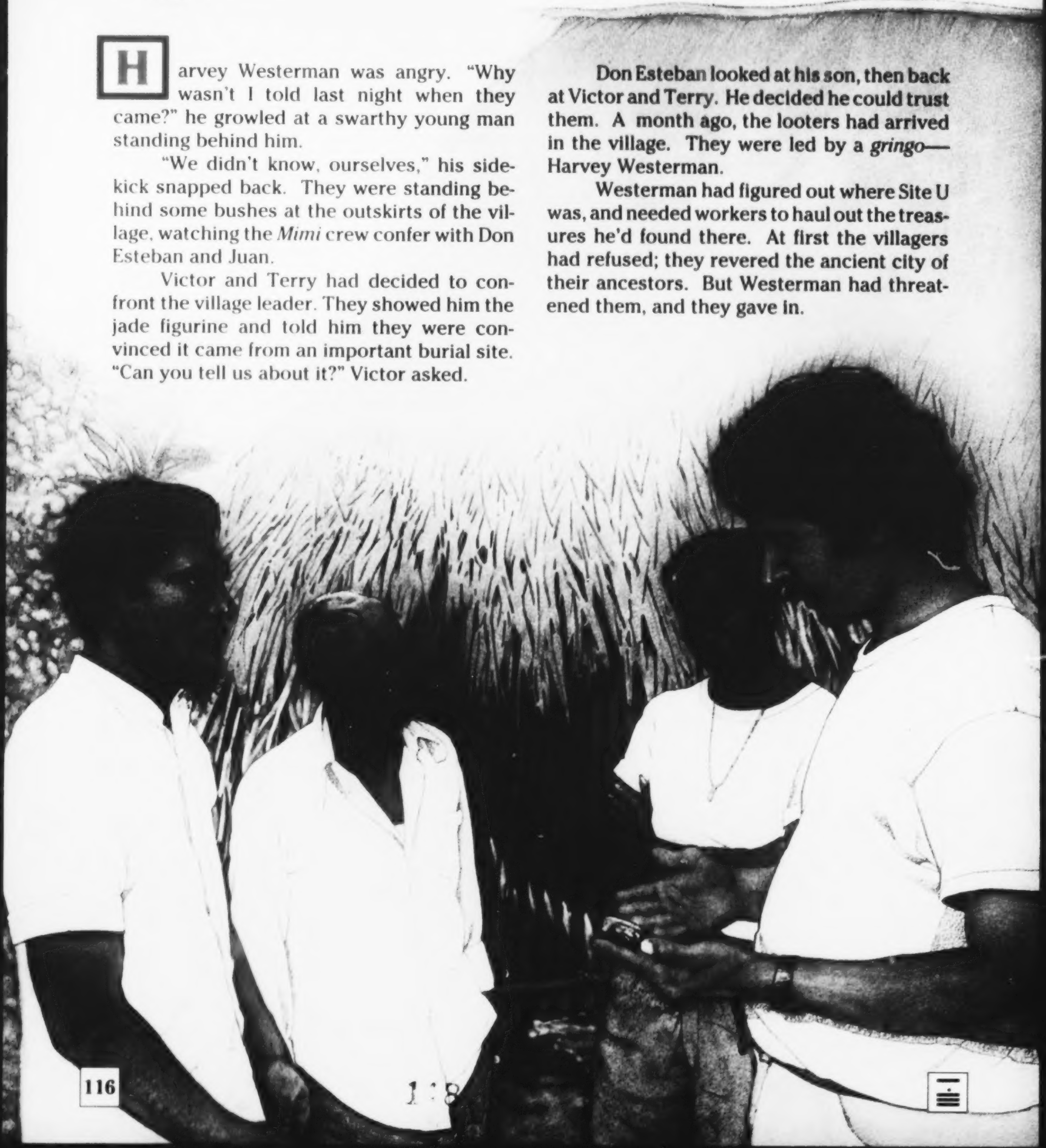
Harvey Westerman was angry. "Why wasn't I told last night when they came?" he growled at a swarthy young man standing behind him.

"We didn't know, ourselves," his sidekick snapped back. They were standing behind some bushes at the outskirts of the village, watching the *Mimi* crew confer with Don Esteban and Juan.

Victor and Terry had decided to confront the village leader. They showed him the jade figurine and told him they were convinced it came from an important burial site. "Can you tell us about it?" Victor asked.

Don Esteban looked at his son, then back at Victor and Terry. He decided he could trust them. A month ago, the looters had arrived in the village. They were led by a *gringo*—Harvey Westerman.

Westerman had figured out where Site U was, and needed workers to haul out the treasures he'd found there. At first the villagers had refused; they revered the ancient city of their ancestors. But Westerman had threatened them, and they gave in.



"Why didn't they tell us?" Quiché asked. They hadn't told because Westerman had warned them not to tell anyone about the temples, especially not archaeologists. He had frightened them.

"Don Esteban," Terry said, when he finished his story, "will you lead us to the lost city?" He conferred with his son. Tomorrow morning, Juan said, he would take them there.

"They'll be calling the *federales* now," Westerman's henchman whispered. But Westerman wasn't worried. They had all night, time still for a lot of digging.

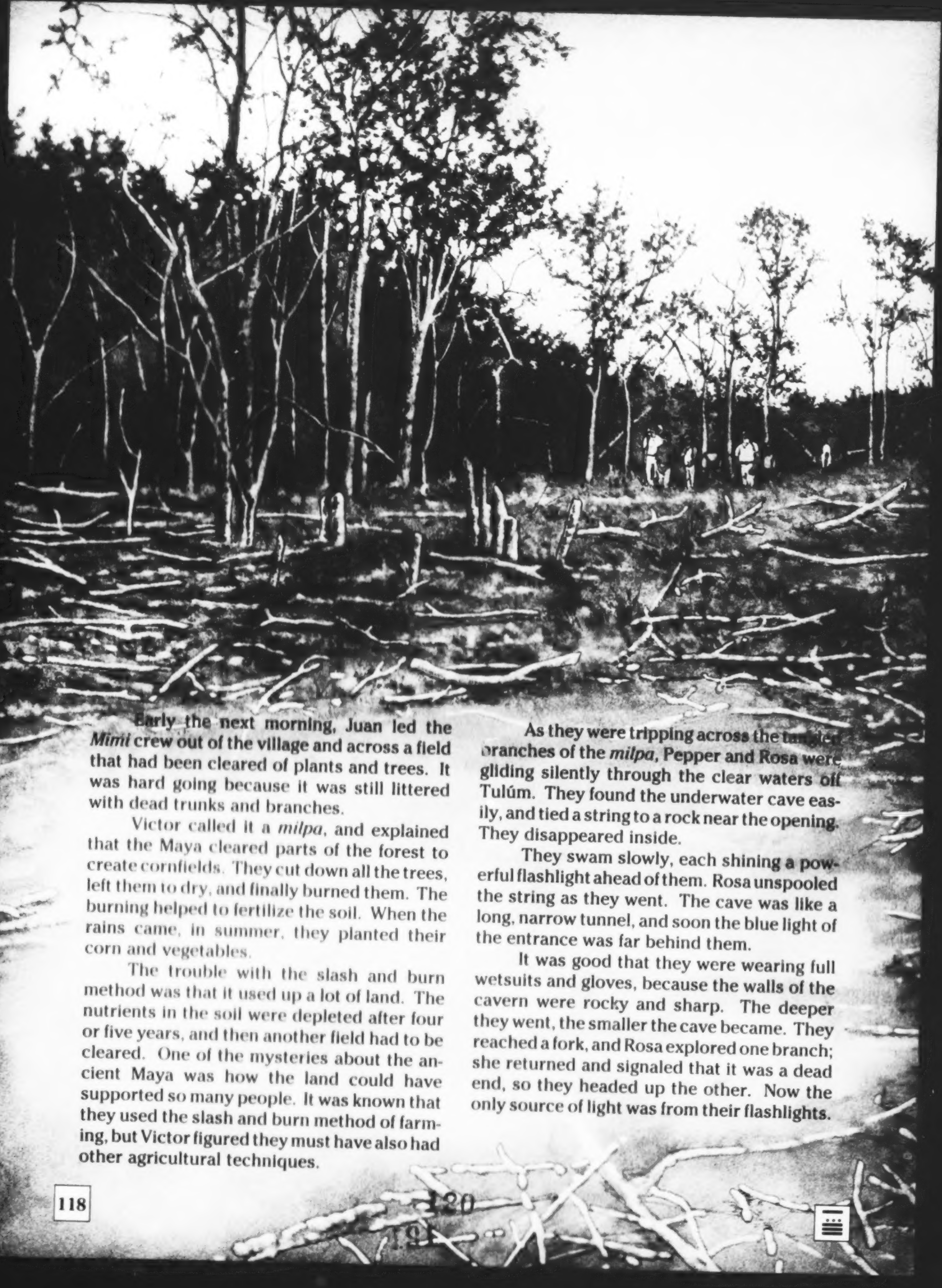
"We'll haul everything out through the ***cenote*** tomorrow night," he said, "after the guards and tourists have left Tulúm."

Back at the *Mimi*, Pepper was singing a song for Rosa, accompanying herself on guitar. "I wish I could do that," Rosa said when Pepper finished. "You can do everything."

"Well, I'm not so hot at tap dancing," Pepper said. Rosa was surprised that she could joke like that, but Pepper had a very matter-of-fact attitude about her disability. She told Rosa that when she discovered that she had bone cancer five years ago, she became determined to beat it.

"Aren't you angry?" Rosa asked, adding that she would be both angry and depressed. No, Pepper said, she'd never really been angry, she'd been scared. Now her attitude was that she felt lucky to still be alive and able to do all the things she still could do.

Like cave-diving. They were both looking forward to the next day, when they planned to explore the underwater cave Pepper had discovered with Terry and Victor. They knew what they were doing; Pepper had taken Rosa diving in caves off Cozumel when she'd been her scuba teacher.



Early the next morning, Juan led the *Mimi* crew out of the village and across a field that had been cleared of plants and trees. It was hard going because it was still littered with dead trunks and branches.

Victor called it a *milpa*, and explained that the Maya cleared parts of the forest to create cornfields. They cut down all the trees, left them to dry, and finally burned them. The burning helped to fertilize the soil. When the rains came, in summer, they planted their corn and vegetables.

The trouble with the slash and burn method was that it used up a lot of land. The nutrients in the soil were depleted after four or five years, and then another field had to be cleared. One of the mysteries about the ancient Maya was how the land could have supported so many people. It was known that they used the slash and burn method of farming, but Victor figured they must have also had other agricultural techniques.

As they were tripping across the tangled branches of the *milpa*, Pepper and Rosa were gliding silently through the clear waters off Tulúm. They found the underwater cave easily, and tied a string to a rock near the opening. They disappeared inside.

They swam slowly, each shining a powerful flashlight ahead of them. Rosa unspooled the string as they went. The cave was like a long, narrow tunnel, and soon the blue light of the entrance was far behind them.

It was good that they were wearing full wetsuits and gloves, because the walls of the cavern were rocky and sharp. The deeper they went, the smaller the cave became. They reached a fork, and Rosa explored one branch; she returned and signaled that it was a dead end, so they headed up the other. Now the only source of light was from their flashlights.

Meanwhile, the rest of the *Mimi* crew followed Juan toward the lost city. C.T. was surprised when they found a murky pond in the middle of the jungle. He was even more surprised when he heard a loud barking overhead and looked up to see a howler monkey ambling along a branch high in the treetops.

"Wow! Did you see it?" he asked Quiché.

"Yeah," she said. "There aren't many monkeys around here anymore. They keep cutting down their homes."

"Seems like a safe home here, on the pond," C.T. said.

"It's called a *cenote*," Quiché said.

C.T. had the sinking feeling that he was about to learn all about *cenotes*. It seemed everybody knew so much more about the Yucatán and the Maya than he did.

His grandfather pointed at the pond. "*Cenotes* are like natural wells," he announced. "Under the topsoil in this area, there is a layer of limestone. In some places water runs under the limestone and wears it away enough that it collapses, like here."

Now how did he know that? C.T. wondered.

The monkey howled again. With Juan in the lead, the group walked past the *cenote* and continued on through the jungle.

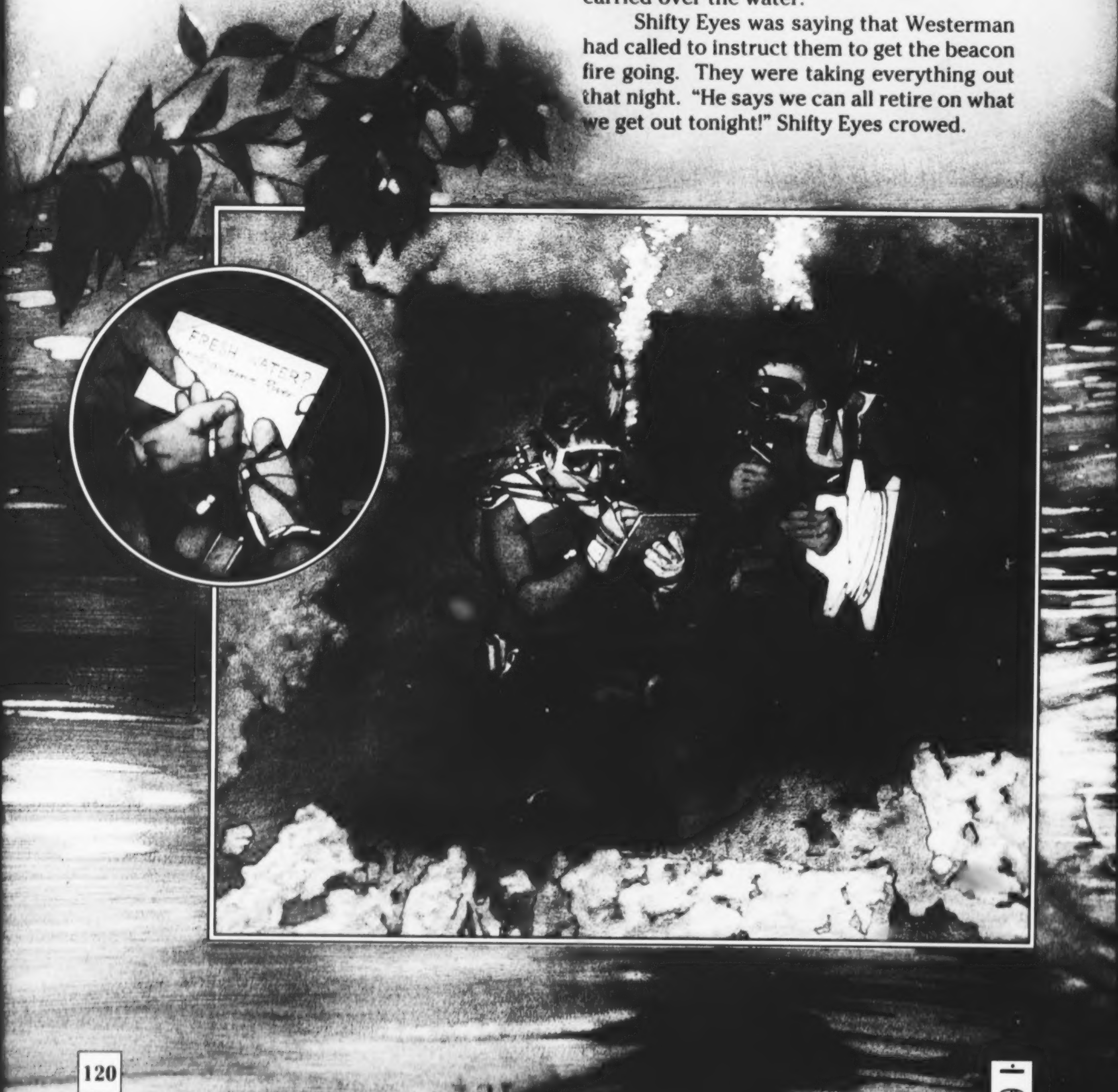
Something seemed different, Pepper thought. She took her regulator out of her mouth and licked her lip. Rosa did the same thing, then reached for their writing tablet. She wrote something and passed it to Pepper. "Fresh water?" it said.

"Underground river," Pepper wrote. They looked at each other and nodded. They swam on.

Soon they emerged from the tunnel and found themselves in a large pond. It was light again. They could see the sky and trees as they rose upwards through the fresh water. In a moment they broke the surface and looked around. They were in a *cenote*.

They heard sounds on the far side and looked over. Two men were moving air tanks from the back of a truck to the edge of the water. Pepper recognized one of them. It was that weasel from the curio shop. Their voices carried over the water.

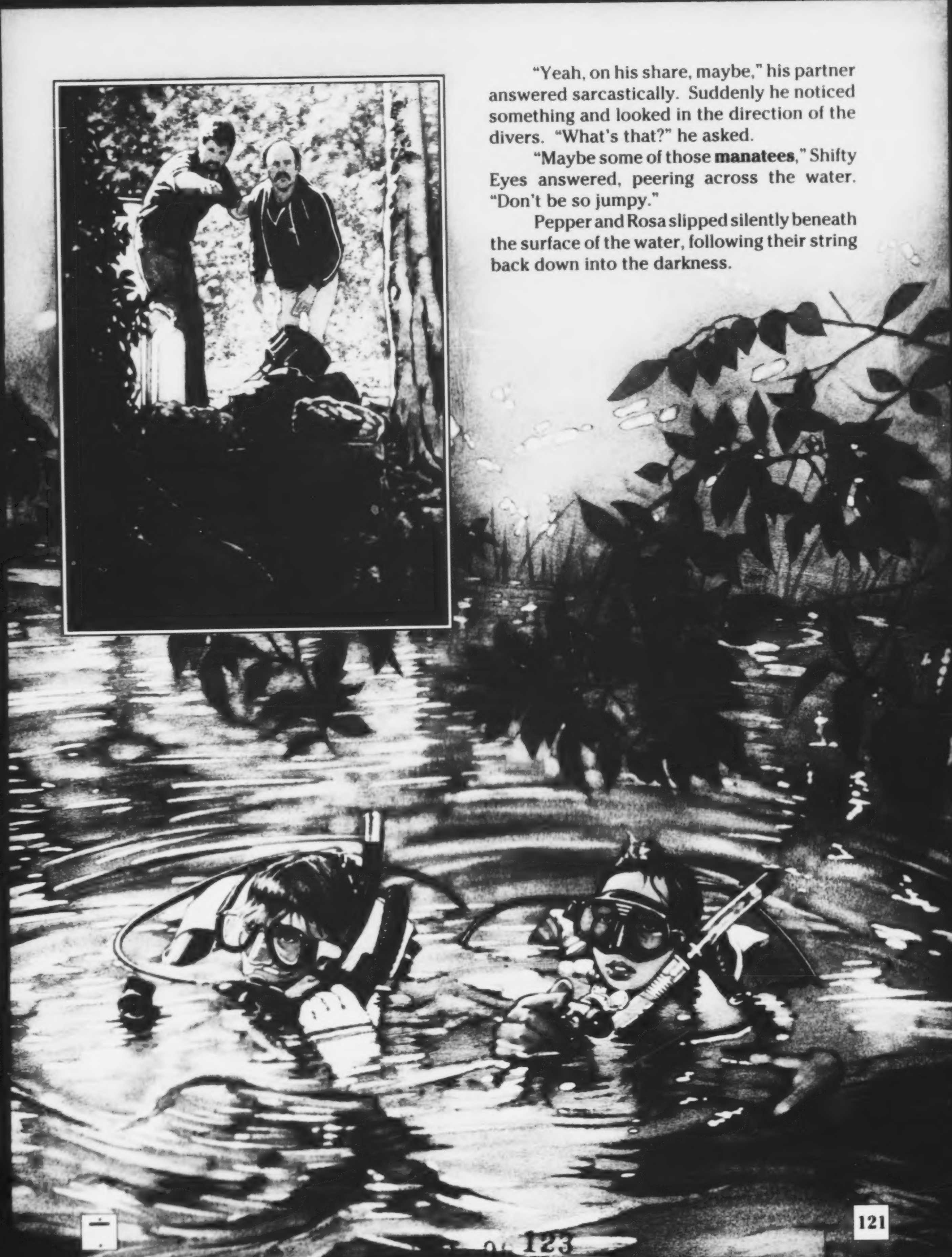
Shifty Eyes was saying that Westerman had called to instruct them to get the beacon fire going. They were taking everything out that night. "He says we can all retire on what we get out tonight!" Shifty Eyes crowed.



"Yeah, on his share, maybe," his partner answered sarcastically. Suddenly he noticed something and looked in the direction of the divers. "What's that?" he asked.

"Maybe some of those **manatees**," Shifty Eyes answered, peering across the water. "Don't be so jumpy."

Pepper and Rosa slipped silently beneath the surface of the water, following their string back down into the darkness.

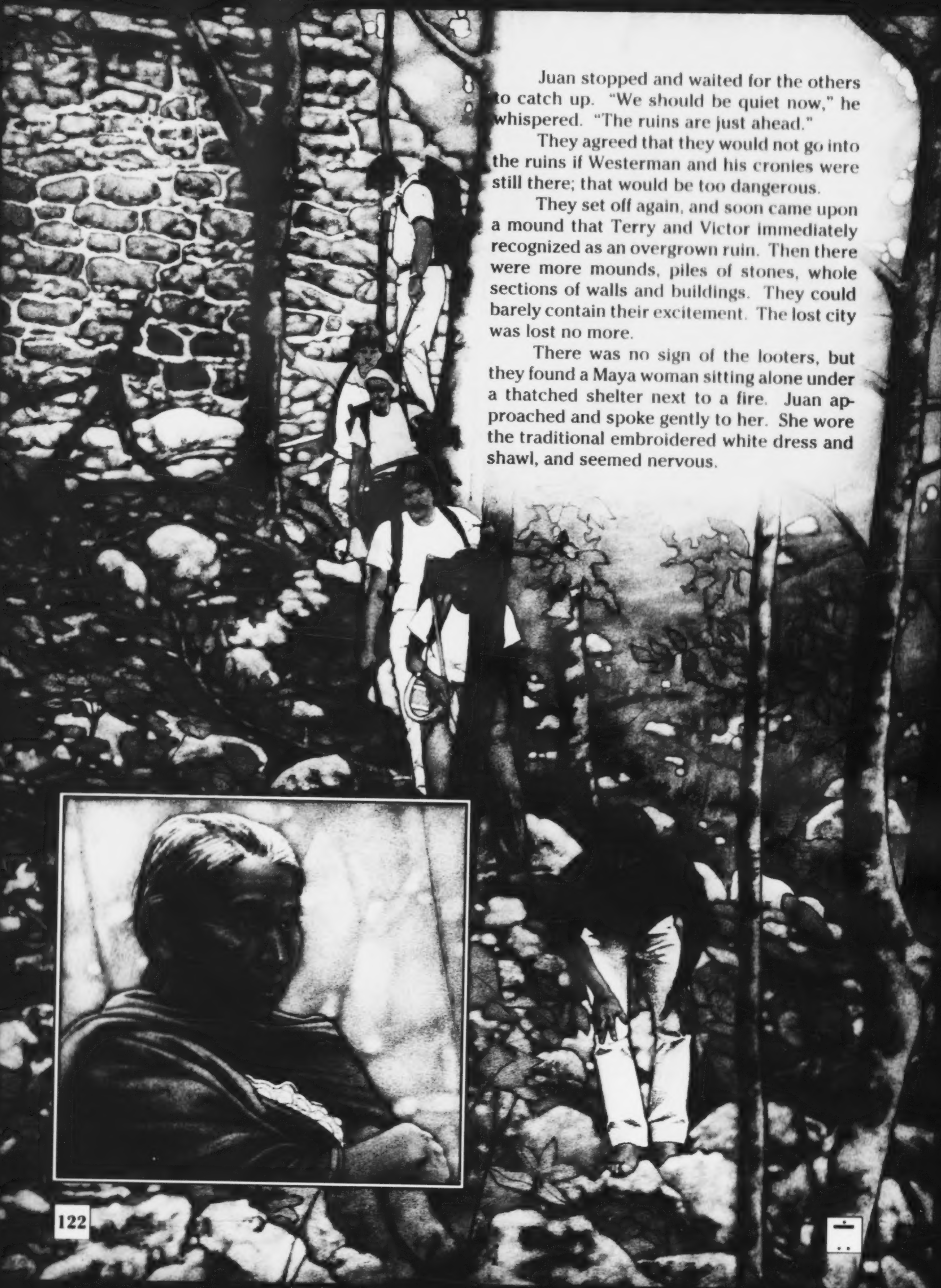


Juan stopped and waited for the others to catch up. "We should be quiet now," he whispered. "The ruins are just ahead."

They agreed that they would not go into the ruins if Westerman and his cronies were still there; that would be too dangerous.

They set off again, and soon came upon a mound that Terry and Victor immediately recognized as an overgrown ruin. Then there were more mounds, piles of stones, whole sections of walls and buildings. They could barely contain their excitement. The lost city was lost no more.

There was no sign of the looters, but they found a Maya woman sitting alone under a thatched shelter next to a fire. Juan approached and spoke gently to her. She wore the traditional embroidered white dress and shawl, and seemed nervous.



She told them that the looters had made her stay out there as their cook. Last night they had forced the Maya workers to work until sunrise. Westerman knew that the *Mimi* crew would soon be there, so he had left that morning, taking the Maya villagers along as porters.

She pointed out the trail they had taken. "*Muy malos*," she muttered somberly.

"*Si.* Very bad men," Terry agreed. "I'm trying to decide whether to laugh or cry. Westerman may have beat us here, but look what he led us to."

They slipped off their packs and gazed around in wonder. "Hey, you guys," Quiché called. "Look!" She was looking at something through the trees, and they all came over to see what she had found.

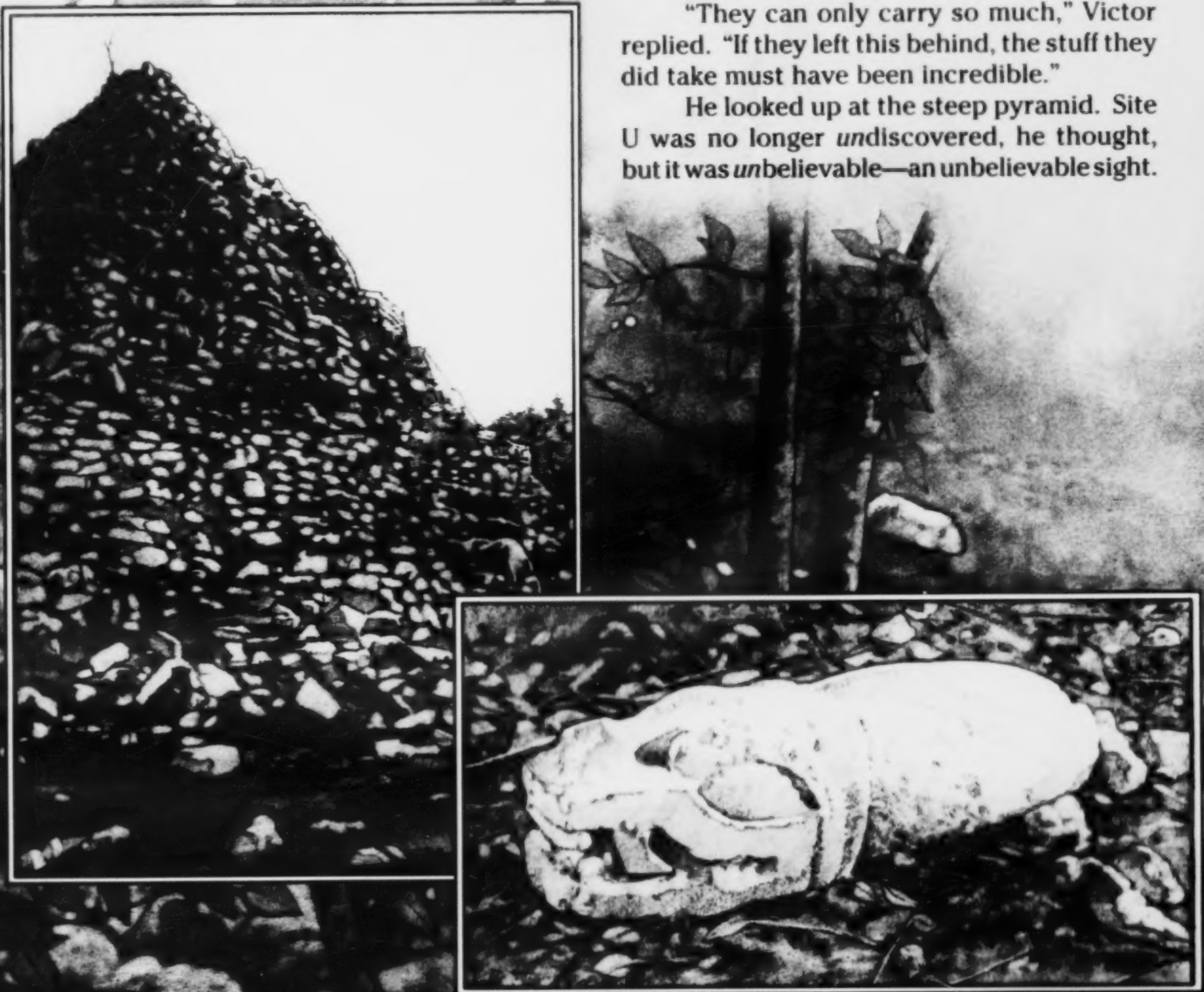
There, in a clearing, stood a pyramid, towering over the forest. They stared at it, awestruck, disbelieving, then ran over to put their hands on it. Not only was it real, it seemed to be in good shape, and some of the rubble and vegetation had already been cleared off by the looters.

C.T. bounded up the steep steps. Quiché was about to follow, but noticed a large carved stone lying on the ground. It was the head of a snake.

"Why didn't they take this?"

"They can only carry so much," Victor replied. "If they left this behind, the stuff they did take must have been incredible."

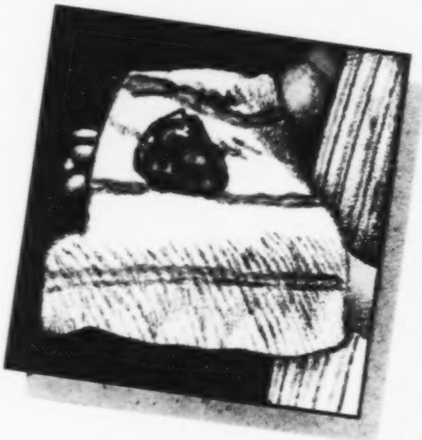
He looked up at the steep pyramid. Site U was no longer *un*discovered, he thought, but it was *un*believable—an unbelievable sight.



-ACTIVITY-

The Plot Thickens

"The Second Voyage of the *Mimi*" has been full of discoveries about the Maya, archaeology, science, math, nature and people. The pictures on these pages show some of the important things members of the *Mimi* crew learned or discovered. Each line of dialogue belongs to a picture. Try to match each picture with the dialogue.



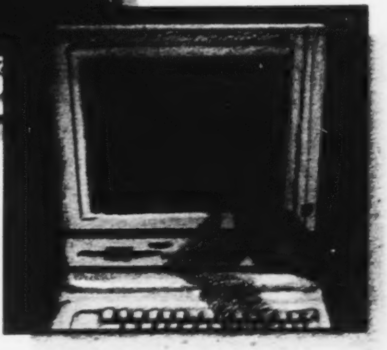
2. "How could one half of a 500-pound monument get from here to Tulúm?"

3. "When I saw a bunch of leaves walking around, I really thought the heat was getting to me."

4. "As the clay got hotter, it gave off a lot of luminescence, light energy."

1. "Well, if it had been down there for even a few months, it would have something growing on it, like algae or even coral. You can imagine what it would look like after a thousand years or so."

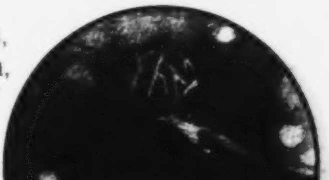
8. "This big stone was on top of the sarcophagus—the coffin. It tells all about Pacal and his ancestors."



5. "Esto es un regalo para ti."

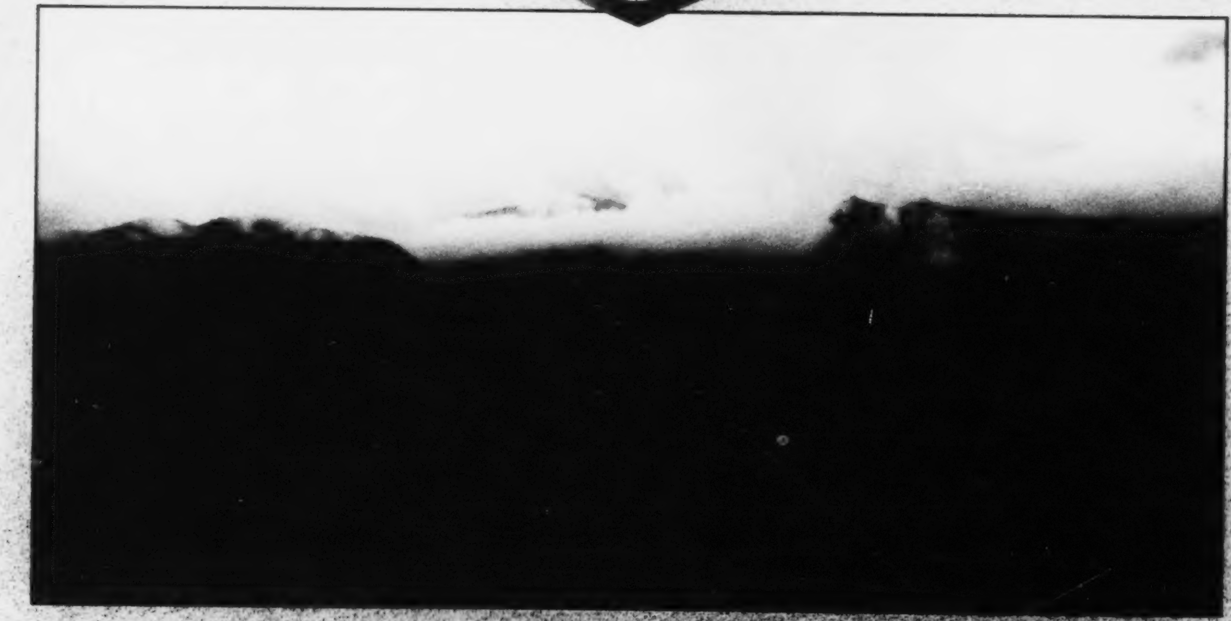
6. "We shouldn't move it 'til my mom sees where it is."

7. "Then this says, 'chac ba la ma, Chac Balam.'"



9. "If you're on a boat out there and you can see the light from the fire through that small window in the temple, you're on the right course to get through the reef."

EXPEDITION



Tropical forests are being destroyed at the rate of 100 acres every minute.

Tropical forests, like the one at Palenque, are really fantastic places, but they are disappearing fast. Carla Douglin went all the way to Costa Rica, in Central America, to meet a woman who is helping to protect **tropical forests** by learning more about how they grow and survive. Her name is Nalini Nadkarni.

Costa Rica is a small country about five hundred miles southeast of Mexico. It used to be covered with tropical forest, but now a lot of the forest has been cut down for lumber and to make pasture for farm animals.

Cutting down so much jungle around the world hurts all of us. Tropical forests are home to thousands of **species** of plants and animals that have never been studied and exist nowhere else. They could be the source of new knowledge about the earth or new foods or medicines, maybe even cures for cancer. The great rain forests near the **equator** affect the climate and atmosphere of the whole world.

Now, a hundred acres of tropical forest are destroyed every minute. At that rate, we lose an area of forest the size of Kansas in just one year. Fortunately, there are still some big areas of tropical forest in Costa Rica. The one Carla went to is high up in the mountains. In fact, its name, Monteverde, means "Green Mountain."

Nalini Nadkarni is a tropical **biologist**. Nalini lives in a cabin high on the mountaintop at Monteverde with her husband, Jack. He is also a tropical biologist. Nalini has borrowed mountain climbing techniques to do her research high up in the canopy or treetops of the rain forest.

Nalini and Carla sat on the porch of her house and talked about Nalini's work. "We started a project a few years ago, to study the epiphytes in the canopy of the tropical rain forest," Nalini said.

"Epiphytes?" questioned Carla.

"Epiphytes is a very general name for any plant that grows on another plant. We're trying to understand how they interact with other parts of the forest," Nalini explained. "In tropical rain forests, the interactions between plants, animals and soil are very complicated and really important, but we still don't know much about them." Learning more about those relationships may help save rain forests that have been damaged by humans.

"The best way for you to find out about them is to climb a tree yourself," said Nalini. She handed Carla a coil of climbing rope and picked up the rest of the tools herself. They walked through the forest and into a clearing where a few huge trees stood. Nalini pointed at a giant tree that was covered with mosses, vines and other plants growing on its trunk and branches.

"I thought this tree would be a super one for climbing, especially for your first time. It's nice and tall with lots of big branches," Nalini said, pointing up.

"It's an awfully big tree," Carla said. "What kind of a tree is it?"

"This is a really interesting kind of tree. It's called a strangler fig. It starts its life up in another tree, on a branch. Then it grows its roots down. The roots follow the trunk all the way down to the ground. When the roots of the fig get down to the ground, it starts growing faster and faster. Finally, the fig itself grows bigger than the tree it started on. Pretty soon, all that's left of the whole tree is the strangler fig. So this tree is actually a strangler fig. There's nothing left of the original tree. Isn't that incredible?"

Carla agreed it was pretty incredible.

"So now we have a strangler fig with all these other plants growing on it. They're really neat," added Nalini.

Nalini has invented a special tool called a "Master-caster" to help her get up the trees. It's a slingshot with a fishing reel attached. With the Master-caster Nalini can shoot a line up into the canopy. If she misses the branch she was aiming at, it is easy to reel the line back in and try again.

Nalini tied a fishing weight to the end of the fishing line. She took aim as Carla flipped the bail on the fishing reel. Nalini shot. The fishing weight fell just short of the branch Nalini was aiming at. She reeled it in and tried again. This time, the weight and line sailed over the branch.

"Now comes the fun part, in which we 'twingle' the line down," Nalini said. With a graceful motion she sent a ripple through the line. At the other end, the fishing weight slipped down a little. She kept rippling the line, and bit by bit the weight pulled the line over the branch and toward the ground, until Nalini could reach it on the other side.

Then Nalini removed the weight and tied a heavier, stronger line onto the fishing line, using a strong knot called a **bowline knot**. When she had pulled that heavier line back over the branch she was able to use it to hoist her heavy climbing rope. Finally, the climbing rope was safely over a big, strong branch. Nalini and Carla tied one end of the rope around the trunk of a nearby tree to secure it.

Nalini then rigged a second rope for Carla and taught her how to use the climbing gear. First Carla had to put on a climbing harness made of strong webbing. It was very simple—two leg loops and a belt that wrapped around the hips. Carla put her legs through the two leg loops and pulled up the harness. Nalini adjusted it so it was nice and tight. On the front she hooked a metal loop called a **carabiner**. The carabiner has a hinge that allows you to open it and a screw clamp that allows you to lock it so it can't open by itself.

Getting ready for Carla's climb

(Facing page) Carla and Nalini were 100 feet above the forest floor in another world where no humans had ever been.

Carla quickly learned the technique for climbing. It was an exciting—and scary—experience.

The most ingenious piece of equipment is the **ascender**. This is a small metal clamp with a triangular or wedge-shaped piece that has teeth on one side. The ascender slides easily up the rope, but when you pull down on it, the teeth "bite" onto the rope and hold it in place.

Nalini attached one ascender to the leg loops so Carla could move it with her legs and one to the seat harness which she could move with her hands. So with the two ascenders clamped onto the rope, Carla could inch her way up the rope like an inchworm.

"Stand up, and in one smooth, coordinated motion slide the ascender up the rope," instructed Nalini.

Carla stood up, sliding the ascender up the rope. She pulled her knees up, which brought the other ascender up. She straightened her knees as if she were standing up, and used her hands to push the top ascender up again. She picked the technique up quickly.

When Nalini saw Carla was safe and confident, she put on her own harness and started climbing up the second rope they had rigged. As they were inching their way up into the canopy, Nalini and Carla chatted.

"There's no way you can fall," Nalini assured Carla.

"Are you sure?" Carla asked nervously.

"This is always the exciting part, because you never know what you're going to find up there," Nalini said. "Just think, nobody has ever been up there except monkeys and birds and plants. So you're the first human who has ever walked up there."

Carla looked around appreciatively as she hung, suspended like a spider on a piece of silk, fifty feet above the forest floor. It was neat to see the ground from a different perspective, the way birds see the world.

As they continued to inch their way up, Nalini pointed out some plants that were growing out of the tree trunk. They looked like pineapples and there were pools of water collected in the center of each one. "Those are tank bromeliads. From the top you can really see the way they are put together. They're really good at collecting and holding onto rain water. They act like little ponds. Birds come and drink water from them and actually take baths in them. The bromeliads are a very important group of epiphytes."

Nalini climbed ahead of Carla and managed to swing over to the big branch the rope was around. Once she had scrambled onto it, she gave Carla a hand.

"My hands are starting to burn," said Carla, relieved.

"After a while you get really good callouses on your hands," Nalini said. "You can just slip up and down the rope with no problem at all."

Dangling beneath the branch where Nalini waited, Carla kicked her legs out of the leg loops. Nalini reached out and pulled her toward the tree. Carla swung her legs over and clambered onto the branch with a boost from Nalini.

"I'm on a tree!" Carla exclaimed. "How high do you think we are?"

"We're about thirty meters high. That's close to a hundred feet."

"Wow! I don't believe I did it."

"You did it!" said Nalini.

"All by myself...well, with some help from you." Carla looked around from her perch in the strangler fig tree. "This is amazing."

(to be continued)

WHERE HAVE ALL THE FORESTS GONE?

Rain forests are the oldest, most complex biological communities on earth. They have been **evolving** for over 60 million years. Almost half the species of plants and animals in the world live in the rain forest. Yet, in the past 200 years, over half the world's rain forests have been cut down. And one of the forest's species of plants or animals becomes extinct every day, because as the forests are cut, animal and plant habitats disappear.

Many scientists are very gloomy about the future of the rain forests. Can you see why?

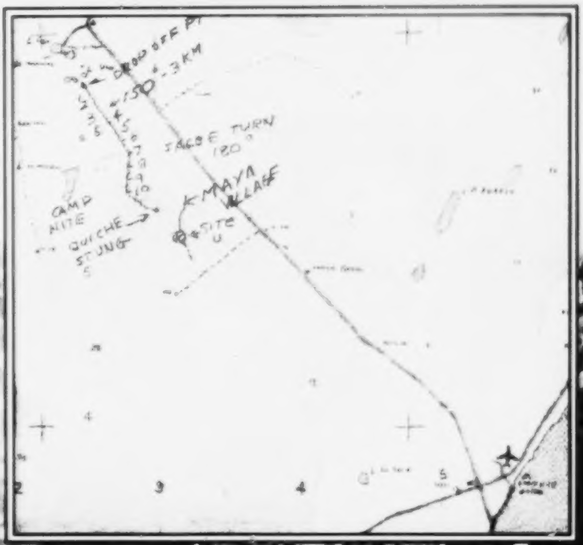
About 225 square miles of rain forest are cut down or burned every day, usually to make room for people to live or pasture for domestic animals. At that rate, how much rain forest is lost in a year?

There are about 3 million square miles of rain forest remaining in the world now. If the current rates of destruction continue, how many years will it be before all the rain forests in the world have been destroyed?

Captain Granville tried to raise the *Mimi* on the radio, but there was no answer. "*Mimi*, do you read me?" he said one last time. Silence.

He rejoined the others, who were still exploring the site. "I guess we shouldn't be too unhappy," Terry was saying. "There must be dozens of major structures around here."

"Shouldn't we follow the looters?" C.T. asked, as he hopped down the last few steps of the pyramid.


DROP OFF PT
150° 3KM
JACOB E TURN 180°
MAYA VILLAGE
CAMP NITE
QUICHE STUNG
SITE U
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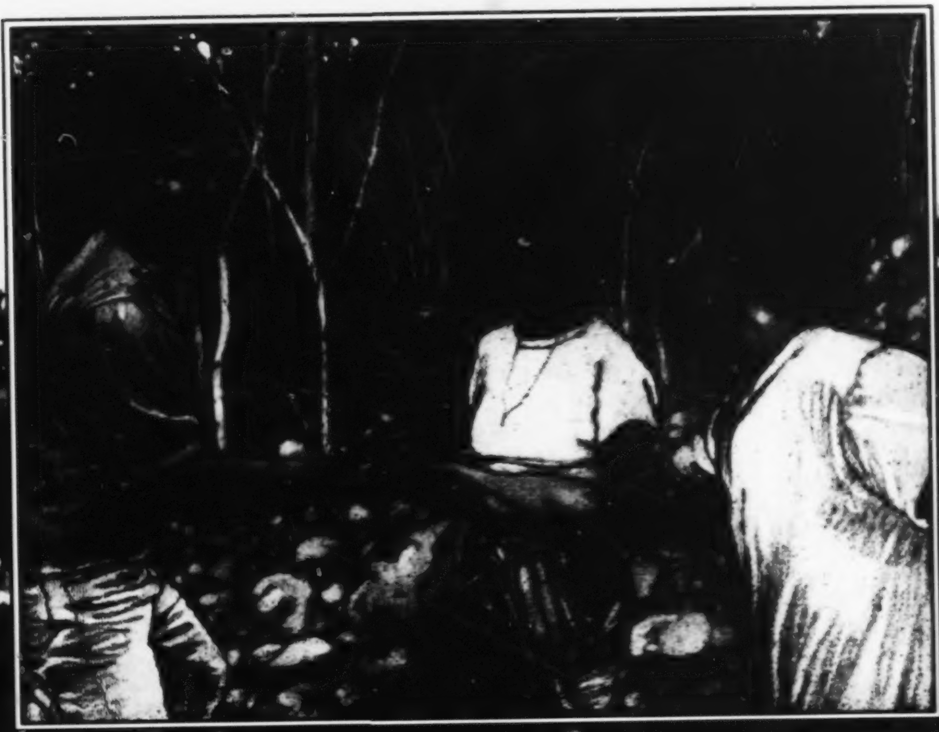


"They've got six hours on us, C.T.," Victor answered.

"That might not be too much," Captain Granville said. He pointed at the map he and C.T. had been keeping. It was a log of their trek, charting their southerly progress along the *sacbe* to the place where Quiché was stung by the scorpion, then on to the village, and finally to where they now stood, Site U.

Granny pointed out a road that lay a few miles east of their present position. Westerman had gone in that direction, and the Captain figured he had a truck waiting for him there. From there he would drive to Tulúm, but he would have to wait until dark to move the loot out to his boat.

"If we hustle, and we have some luck hitchhiking, we could get to Tulúm in time to stop him," the Captain concluded.

Everyone was up for that. They quickly collected their backpacks. The Maya woman gave them some tortillas for their hike. "*Yum botik*," they said to Juan, thanking him for his help. Then they left the lost city and disappeared into the jungle.

Meanwhile, Pepper and Rosa followed their string back towards the cave's entrance. "Who were those men?" Rosa asked, as soon as they surfaced next to *Mimi*.

"Cronies of that guy Westerman I told you about," Pepper answered. "I'm beginning to see how they operate."

At that very moment, Westerman was leading his Maya porters through the jungle at a rapid clip. It was easy for him; he wasn't carrying anything, and he was on his way to the biggest payday of his life. The Maya were burdened with heavy burlap packages containing the looted artifacts from Site U. They carried the packages on their backs, supported by a strap that strained against their foreheads. That wasn't the only way they were using their heads, though. They were snapping twigs along the way, marking their trail.

Victor was leading his party along the same path. They were making good progress until they arrived at a fork. Which way to go?

For once C.T. had the answer. He'd spent a lot of time out in the woods in Ohio, and he knew how to follow a trail. He'd been noticing the broken twigs and he looked for one now. When he saw one a few feet down one of the trails, he knew he was right. The break was so fresh that the leaves hadn't even died. He was sure the villagers were marking the way for them.

Victor was impressed. "Why don't *you* lead us for a while, *amigo*," he said.

They took a water break an hour later. They finally managed to get through to Pepper on the radio. She was relieved to hear that Quiché was O.K., and amazed that they had actually found the lost city. But Granny didn't have time to go into details. He warned her that Westerman was on his way, and would probably try to take the loot out that night.

"You know, Pedro, I could learn to hate that man," the driver whispered to Shifty Eyes, who had accompanied him from Tulúm.

"You are a slow learner, then," was all Pedro had to say.

Back in the jungle C.T. suddenly came to a dead stop. "What are we going to do if we happen to catch Westerman?" he asked as the others pulled up behind him. It had just occurred to him that they were chasing a serious criminal, probably a dangerous one.

"*I'm* not afraid of Harvey Westerman," Quiché announced bravely, causing the Captain to grin.

"Catching him is not our purpose. *Tracking* him is," Victor emphasized.

Pepper had a pretty good idea how he got it out to the boat without being seen. She started to tell Granny, but he was more concerned with her safety. He wanted her to get *Mimi* out of there and to play it safe. She should call INAH and see if they could get the federal police there.

"Don't start trying to play detective," he said, "and that's an order. Understood? Over."

"*Si*, understood. *Buena suerte*. Over."

"Good luck to you too. Over and out."

Pepper stood in thought for a moment, then turned to Rosa. "I think I've got an idea that might stop Westerman," she said.

Rosa gave her a worried look. "I hope you know what you're doing."

"Me too," Pepper said.

Westerman arrived at the road. It stretched out straight and empty in both directions. When the truck finally did arrive, Westerman blew his lid. He bawled the driver out while the Mayas loaded their heavy cargo into the back of the truck.

"We'll leave the catching part to INAH and the *federales*," Granny added, still amused at the picture he had in his mind of a showdown between Quiché and Westerman.

"Sure," C.T. said, though he really wasn't sure. What if Pepper didn't get through to the police? Would they just stand by as Westerman sailed off with invaluable chunks of Maya history?

Back on *Mimi*, Pepper cut the engine and threw the anchor over the side. "Do you think we'll be safe here?" Rosa asked her.

"*Mimi* will be safe," Pepper answered. "We're going back to Tulúm."

"We are? But Captain Granville..."

Pepper cut her off. "I know, but I think your father can help us. Let's get going."

Westerman dropped his crew and cargo off near the *cenote* in Tulúm. "It's against my better judgment, but I'll have to trust you two to get the stuff out of here," he grumbled to Pedro and his partner. "I'll be at the reef with the boat at nine."

"We'll light the fire on the cliff," Pedro said obediently.

"Yes, you will," Westerman said, giving him a hard look. "Now pay off these Indians and tell 'em to take a walk."

C.T. succeeded in following the trail all the way to the road. "Way to go, C.T.!" Quiché shouted, as they emerged from the jungle.

"Thanks," C.T. said. "Now what?" They looked down the long, empty stretch of road. It was an arrow aimed directly at the coast, but their target was still far away. C.T. remembered the drive to Cobá when they first found the stela. He hoped the traffic would be a little heavier today.

The looters had to make several trips along the underground river that led from the *cenote* to the lagoon inside the reef. Back and forth they went, hauling the stolen artifacts from Site U. At least they weren't as heavy under water as above.

Pedro used a machine that was like a tiny submarine to pull him along. It helped, but it was still hard work. When they emerged from the cave, they swam out a little further and stashed the loot on the sandy bottom, where it would sit until Westerman arrived with the boat. Then they'd haul it up under cover of darkness.

The Mayas sat around the *cenote*, tossing pebbles into the water, waiting to finish with this work they'd been forced to do. One of them was playing with an air tank. He opened the valve and listened to the compressed air hiss out. He shut it off and looked at his friends, smiling. He had an idea. Again he opened the valve, but this time he didn't close it for a long time.

Soon the divers returned. Pedro ordered the Maya to hand him the last of the wrapped stones. His partner climbed out of the *cenote* and removed his tank; he needed a new one. This was the last trip, so Pedro shouted at the Mayas that they should clear out now. They looked at him coldly, and slowly turned to go.

It didn't take long for the diver to realize he was in trouble. He was following Pedro through the underground river, daydreaming about his share of the profits, when he suddenly ran out of air. He snatched the regulator from his mouth and shook it, thinking it must be blocked somehow, but no bubbles emerged. He sucked on it again. Nothing. He flailed around until his hand found his pressure gauge. The needle was on zero.

Pedro couldn't hear the muffled scream behind him. His partner turned, panicking now, and swam as hard as he could. He resurfaced in the *cenote* with a huge gasp, and collapsed on the nearest rock, groaning and struggling for air.

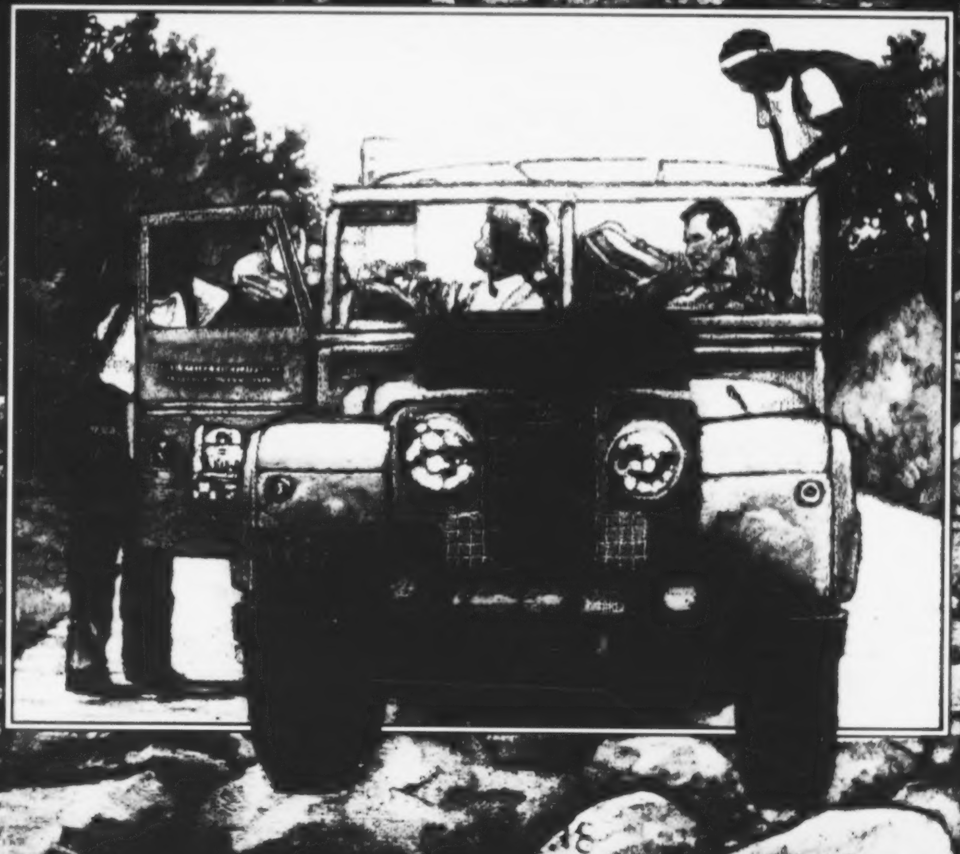
The Maya villagers were waiting. They grabbed him and wrapped a line around his arms and chest. He was too weak to resist. They tied the rope off tightly.

Meanwhile, the *Mimi* gang trudged on. It seemed hotter on the road than in the jungle. No traffic. *Nada.* Not even a donkey. Finally a minibus passed them, but it was going in the wrong direction. It didn't even stop.

At this rate they'd be walking all night, Quiché figured. It wasn't a pleasant idea. Just then she heard an engine in the distance. They all turned. It looked like Jean and George's jeep. It *was* Jean and George! They couldn't believe their luck. They piled into the jeep, all talking at once.

At the same time, in the water off Tulúm, Pedro was tying the bundles of looted relics together, so Westerman could haul them out of the water and onto the deck of his boat.

Meanwhile, George drove the overloaded jeep as fast as it would go, but it seemed as if they'd never get there. It was dark by the time they pulled into Tulúm.



"Hurry!" Quiché shouted, as they scrambled out of the jeep and ran to the edge of the cliff. They got there just in time to hear the throttle of a powerful inboard motor.

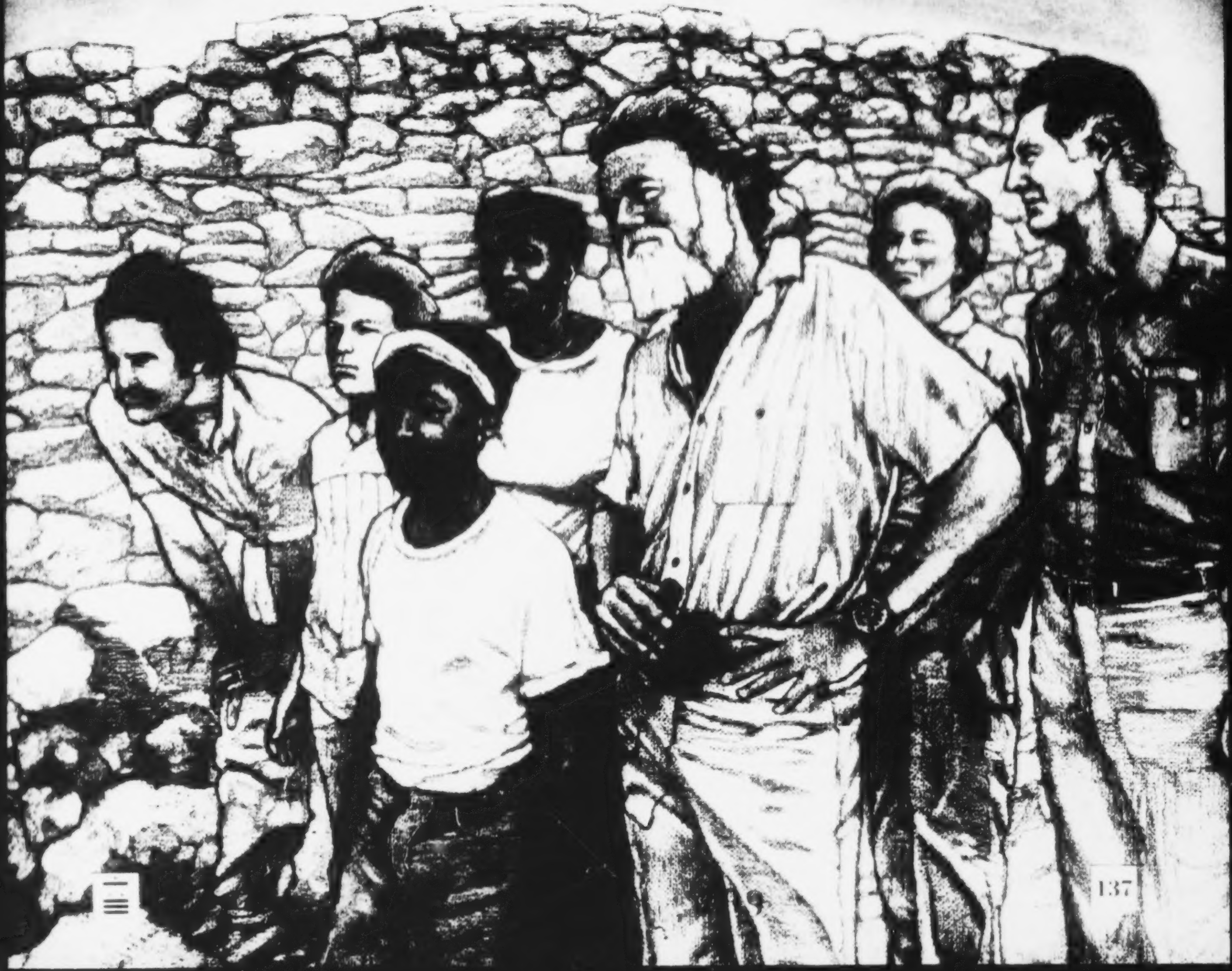
They peered out into the night, straining their eyes. Moonlight was glittering on the water. The sound of the motor led their eyes to a dark shape moving slowly towards the open water beyond the reef.

"Westerman?" Terry asked, although she already knew.

"I'm afraid so," Captain Granville said. "He's running dark."

"Oh no," Quiché groaned.

"We just missed," C.T. said, his heart sinking. They stood in silence, watching helplessly as a few more pieces of the Maya puzzle disappeared from view.



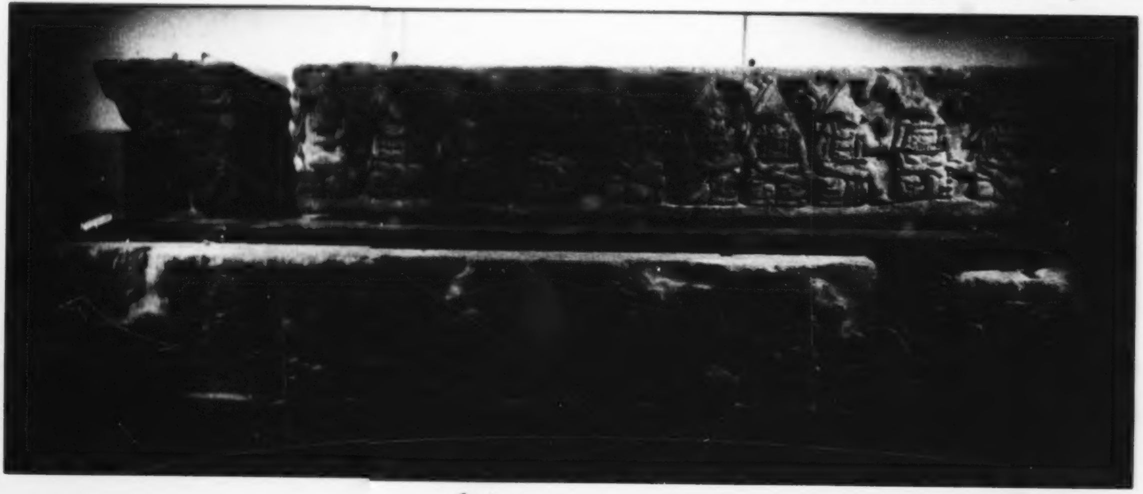
STAMP IT!

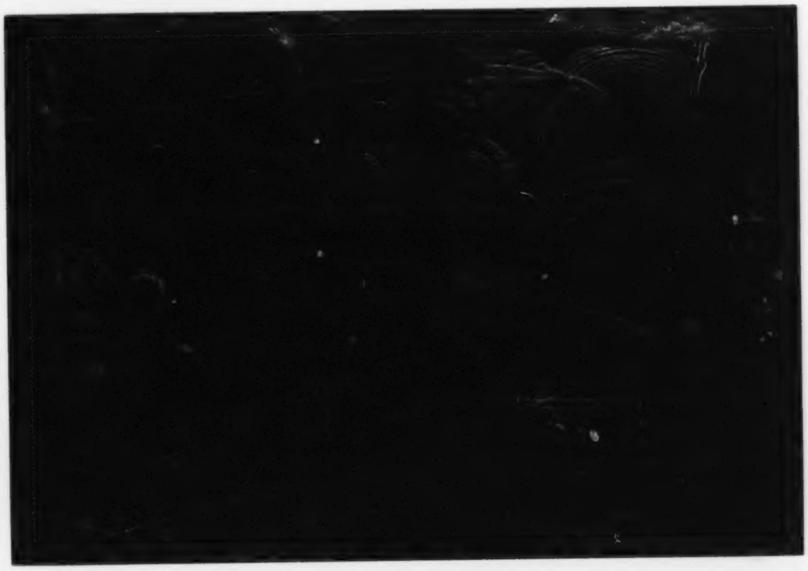
The Maya carved limestone and jade using blades made of obsidian. Obsidian is a kind of volcanic glass that can be chipped to form a very sharp edge. With these simple tools, they created beautiful detail on their buildings, monuments, and jewelry.

Jade portrait pectoral, Middle Pre-Classic Period (1000-600 B.C.).

Cylindrical vessel, Late Classic Period (600-800 A.D.).

Sculpted bench panel, Temple 11, Copán, Late Classic Period (circa 775 A.D.).





Bird Jaguar dressed for battle, Late Classic Period (circa 760 A.D.), Yaxchilán, Chiapas, Mexico.

You, too, can make carvings using simple tools. With a styrofoam meat tray and a pencil, you can "carve" stamps and use them to make beautiful patterns.

Here are some examples of Maya design. Take ideas for your designs from these and from Maya art you see throughout "The Second Voyage of the *Mimi*." Then follow these simple instructions:

1. Cut the curving sides off the meat tray, so you have a flat piece of styrofoam.
2. Plan your stamp on a separate piece of paper. Think about designs that are from 1" to 3" square.
3. Use a pencil (the point should not be too sharp) to draw your design on the styrofoam. Remember that when you print with your stamp, the image will come out backwards. This may only matter if you plan to print words.
4. Cut off the extra styrofoam so there is only a small border around your design.
5. Make a handle for your stamp with a piece of masking tape.
6. You can ink your stamp in a few ways. One way is to buy a stamp pad at a stationery store. Another way is to mix tempera paint with a squirt of liquid soap. Paint this mixture onto a sponge and use the sponge as a stamp pad. Another way is to buy special ink and a "brayer," and roll the ink onto your stamp. A brayer is a small roller, especially made for printing by hand.
7. Experiment with your stamps. You can make many different ones. Use them to create patterns or to illustrate stories.

EXPEDITION

The tree was covered with epiphytes.

Carla Douglin and Nalini Nadkarni 100 feet off the ground in the forest canopy.

One hundred feet high in the canopy of a strangler fig tree in the Monteverde Cloud Forest of Costa Rica, Carla Douglin exclaimed, "Wow! I don't believe I did it!"

She had just been taught to climb this giant tropical tree by tropical biologist Nalini Nadkarni. This way Carla could learn firsthand about Nalini's work. She studies epiphytes—plants that grow on other plants. Trees in this rain forest are covered with epiphytes.

Nalini told Carla that different kinds of plants can be epiphytes: a bromeliad, fern, shrub, moss or lichen. The term epiphyte just describes the way the plant grows. "It perches on a tree," she said. "It doesn't take any nutrients or food from it the way a parasite does. It just uses it for support."

"And the water comes down here and just feeds them?" Carla asked.

"That's right," Nalini said. "The rain comes through the canopy and it drips down and a lot of the water is held by the epiphytes. See how well these mosses hold onto water? It just rained for a few minutes, but they absorbed the water really fast."

"That's important," Nalini continued, "because there's no real soil on this branch to hold onto the water. So the plants have to be super-fast at picking it up. Then they can live through dry periods without drying out. Other plants have fleshy, succulent leaves to hold onto water for a long time. So different plants have different ways of adapting to the kind of environment that the canopy provides them."

"Aren't we actually sitting in an epiphyte?" asked Carla.

"That's true. It was a little fig tree or fig seed that some bird deposited on a tree. It started out its life by being an epiphyte perched on the branch of that tree. Then it started growing down. Now its roots are in the ground, so it's not really considered an epiphyte anymore," answered Nalini.

As the epiphytes grow and die, they create a kind of soil under them that gets several inches thick in some places. It's similar to soil on the ground. One of the things Nalini is trying to find out is how the soil in the trees is different from soil on the ground.

When Nalini was still a student she made a very surprising discovery. In among the roots of the epiphytes she found other roots. These roots grow right out of the branches of the tree itself. It seems a tree like this strangler fig can actually use the soil that the epiphytes build upon its branches.

"It seems from a nutrient standpoint that the epiphytes might really be helping the trees. The trees give support to the plant up here in the canopy. In return the epiphytes are providing a nutrient source that the trees can get into directly. So it's sort of a **symbiotic** or mutually beneficial relationship," said Nalini.

It was Nalini who discovered that a tree could grow roots from its branches. When she first found the roots and realized they were coming from the tree itself, she was excited. "I showed these roots to my professors at my university. I started writing letters and sending **specimens** of the roots to root experts all over the world. I learned that nobody had realized that they exist," Nalini told Carla.

Carla helped Nalini collect epiphyte samples from the strangler fig tree. Nalini wants to know which kinds of plants grow on which kinds of trees. Fruits or flowers are good specimens because they make it easier to identify the plants. Nalini seemed to know something about everything they found up there.

"It's like a whole little pond right here in this bromeliad," she said, pointing to a plant with a little pool of water in it. "You get insects living in there. You get frogs that lay eggs in there. I've even seen snakes go from one branch to another looking into every bromeliad to see if there's anything to eat in there."

Howler monkeys sometimes watch Nalini as if they were watching TV.

The canopy is like a separate world. The forest floor seemed far away. "If we sit up here for a long time, there's a really good chance that a troop of howler monkeys will come through," Nalini said. "They just come, walk around, eat figs. They don't seem to mind me. They sort of yell at first and growl. After a while, they just walk around and look at me, sort of like they're watching TV—watching me sitting in the tree."

"Do you ever yell back at them?" asked Carla.

"Sure, that's what's fun. Sometimes when I do, they answer. Then I keep wondering, gosh, I wonder what I said to them."

Late in the day Nalini's husband, Jack, came by. He's a tropical biologist who studies tropical insects. He agreed to be Carla's safety as she got down from the tree. Carla decided to come down by **rappelling** or sliding down the rope the way a mountain climber does. It's much faster than inching down with the ascenders, but much scarier also.

Nalini helped her wrap the climbing rope under her seat and through a figure-eight shaped device. The figure-eight would create friction to slow her descent. Then Carla had to step out of the tree, trusting the rope to hold her. If she let go, she could fall all the way down. Carla took several minutes to gather her courage. She stepped down and squealed in terror as the elasticity of the rope let her bounce a little. Then she eased herself down slowly and safely. When Carla was on the ground, Nalini let out a whoop and slid down as comfortably as a monkey on a vine.

Coming down by rappelling was faster–but also a lot scarier. If Carla let go, she could fall all the way to the ground.

Nalini uses her cabin as a field lab. Carla helped her sort the epiphyte samples according to whether they were mosses, roots, leaves, twigs, or detritus.

They took the specimens they had collected back to Nalini's cabin to sort them. There were separate bowls for mosses, roots, leaves, twigs and detritus. Detritus was the category for anything they couldn't identify. After it is separated the material can be sent to Nalini's lab in California for more study.

"Now look at this," Nalini said, showing Carla a lumpy thing she found in their samples.

"It looks like a potato," Carla said.

"Yes, it does," Nalini said. "It's a tuber. It's part of a root of a shrub. Remember I was telling you that some epiphytes need to find ways to store water and nutrients because they don't have a lot of reserve there? Well, another way they contend with that, besides having a tank or absorbing water fast, is to make these storage organs that are connected to their stems." Pointing at the tuber she said, "This holds a lot of water and nutrients and sugars, just like a potato does. Pretty funny looking, though. It goes in the root category."

Nalini showed Carla an extraordinary insect she had recently found among her samples. She hadn't noticed it until it started to move. When it was standing still in a pile of moss, it was almost impossible to find.

"Isn't that something?" Nalini gently nudged the insect to make it move. "All those little stickers that look just like moss are really part of its body. It's like your hair or your fingernails. Interactions in the rain forest are

The insect's amazing camouflage makes it almost invisible among the epiphytic mosses where it lives.

so fascinating because you get things like this amazing **camouflage**."

"What made you want to become a field biologist?" Carla asked.

Nalini described how she'd made her decision. "When I was just finishing college, I realized there were two things I liked doing best. One was being out in the field, climbing trees and learning about nature. The other thing was modern dance. I decided the best way to find out which I liked best was to try them both out. When you're in school you don't ever know what it's really like.

"So I wrote letters to different biology stations all over the world—about sixty letters—and asked if I could work as an assistant. I got back about fifty-nine letters that said no. One letter came back from New Guinea, in the South Pacific, and the biologist said he would support me if I could get out there. So I worked for a year in New Guinea on all kinds of biology projects. I really liked being out in the forest and learning about the tropics."

Carla continued sorting specimens as Nalini told her story.

"Then it was time to try being a modern dancer. I went to Paris, France."

"Wow, you lived in Paris?" Carla interrupted.

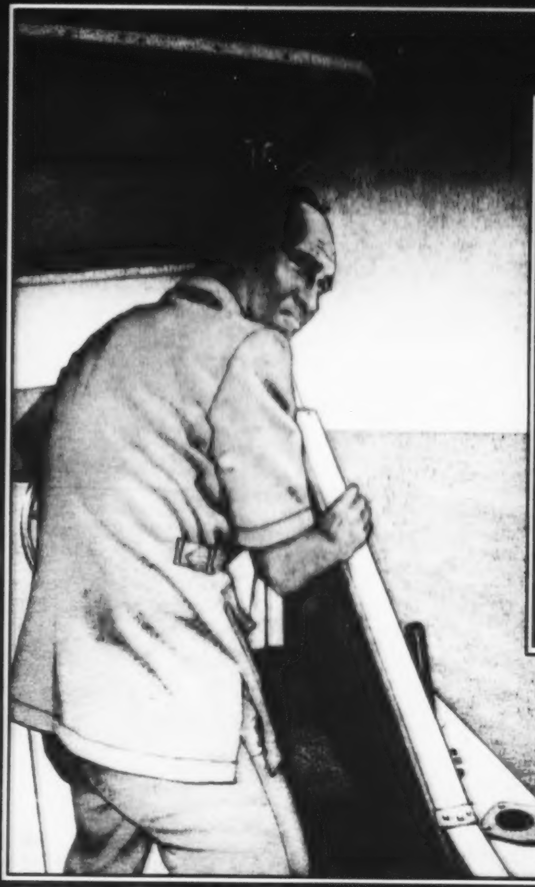
"Yes, in a little attic apartment. I worked at a dance studio for eight hours a day, living the life of a modern dancer. After six months I went to a cafe and had a cup of tea and read over all my old journals. I tried to figure out which would be the best way to live. And I decided I was a lot happier being a field biologist in the jungle.

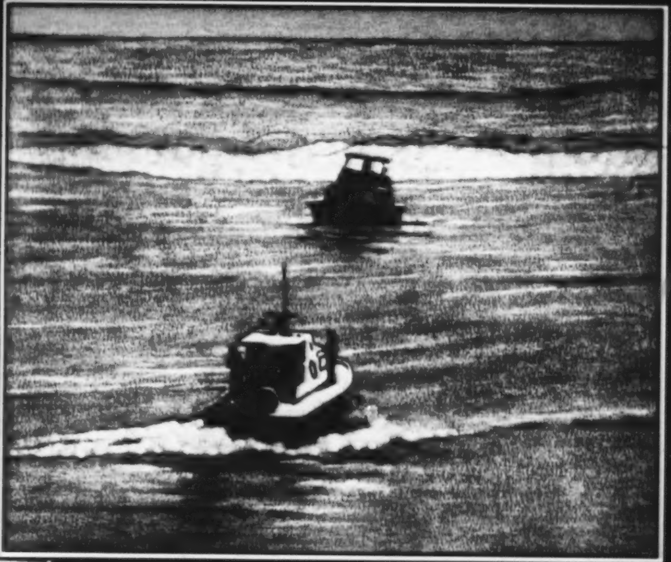
"So, then I decided to go to graduate school. And I turned into a tree-climbing tropical biologist," Nalini concluded with a smile.

ADOPT A TREE

Choose a tree that you especially like. Make sure it's near your home or school so you can visit it all through the year. Make a book of your observations. Hug your tree. Can your arms fit around it? Draw your tree from different points of view: from far away, from underneath, looking up. Make rubbings of the bark or a leaf. Collect samples of things you find under your tree. Can you tell which came from your tree? Observe and draw the creatures that visit your tree in one hour. Do any creatures live in the tree? Look for tiny insects, as well as birds and squirrels. Are there nests in your tree? What kinds of animals built them? Are there other plants growing on your tree—lichens, mosses, or vines? Write a story about a day in the life of your tree in every season. You may want to learn what species your tree is and read more about it.

EPISODE





The waves were breaking out on the reef, catching the moonlight. Once the boat crossed that shimmering silver line, Westerman would gun his engines and vanish into the night forever. They watched from the cliff, waiting in gloomy silence for that moment to arrive.

"Isn't there something we can do?" Quiché finally asked.

"It's too late," Captain Granville answered. "They'll be through that reef soon, free and clear."

Terry sighed. "There goes a boatload of Maya history," she said in dismay. They didn't know exactly what Westerman had on board, but they knew it was valuable. Not only in terms of money, which was all that Westerman saw when he looked at the relics, but in terms of knowledge. Buildings, monuments and artifacts were all that was left of the ancient Maya, and each looted relic was another page ripped from the only diary they left behind.

Westerman was concerned with less weighty matters. He just had to steer his boat through the reef. His sidekick was navigating for him, setting their course by lining them up with the light on the cliff, but it didn't feel right to Westerman. He cursed and turned to take a look. There was the fire, all right, so they *had* to be on course. Still...

Pepper and Rosa found their dejected friends on the cliff, staring out to sea. "Hey you guys!" Pepper called out cheerily. It was nice to see her again, but they felt too glum to say much more than hi.

"Where's *Mimi*?" the Captain asked.

"She's hiding, up the coast," Pepper reported.

C.T. pointed out at the water. "The looters are getting away," he told her, but she didn't seem concerned.

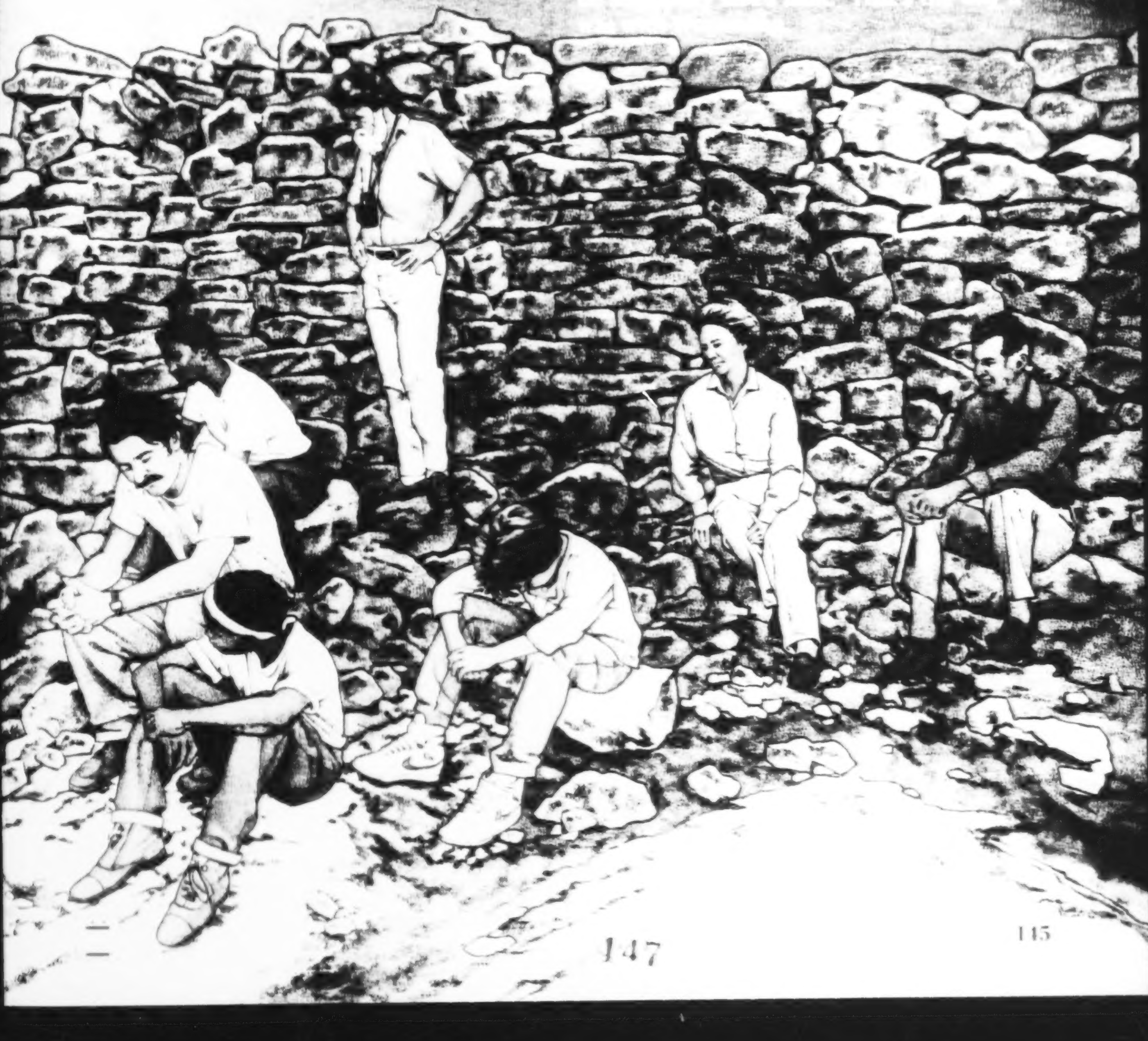
"I think our old friend Harvey is going to have some navigation problems," she announced in a very casual way. They all looked at her. "Just watch," she said. There was a funny little smile on her face.

Westerman turned to check his "lighthouse" on the cliff. He was right on course. "Another fifty meters and we're home free," his sidekick yelled.

"Yeah," Westerman said, breaking into a smile, "home free." He started to relax. The reef was just ahead, and on the other side of the reef lay...

KRRRUNCHHHH!!! There was a terrible sound of ripping and groaning, and Westerman was hurled to the deck. The boat lurched crazily to its port side, the propellers grinding, going nowhere. It was as if a giant claw had reached up from the depths and grabbed the hull in a fierce grip. They had been snagged.

Westerman had landed on his sidekick's lap. "We hit the reef, stupid!" he bellowed as he pulled himself to his feet. It always had to [illegible] That's the way it



There was celebration on the cliff. "He missed the channel!" Granny announced joyfully. "He's stuck on the reef!" They laughed and cheered, and Rosa shook Pepper's hand.

The wail of a siren echoed across the water; the *federales* had arrived, and the police boat sped across the water towards the looters, corralled on the reef.

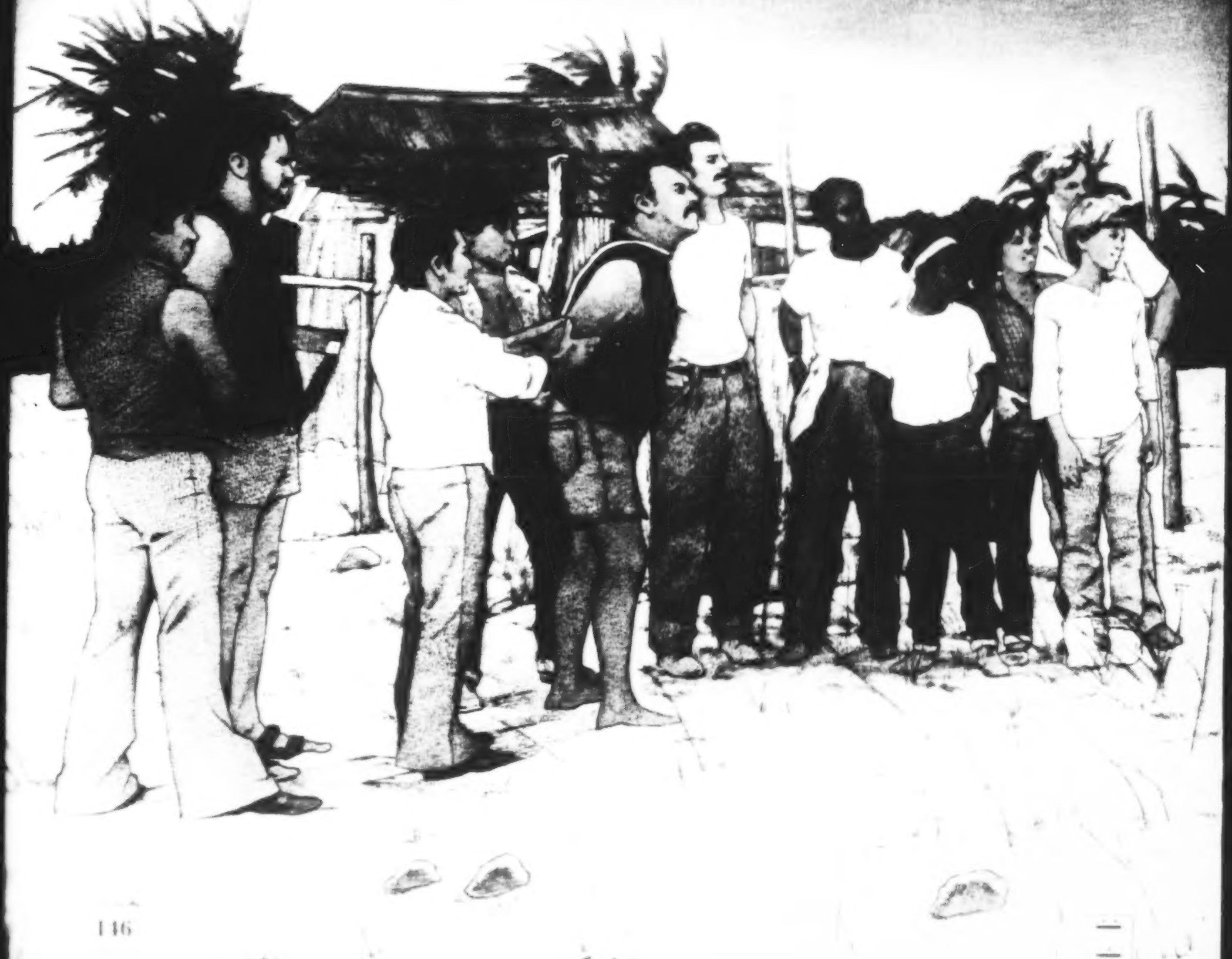
Pepper explained that she and Rosa had moved Westerman's fire—just a few feet, enough to put him on the wrong course when he lined the boat up with his "lighthouse."

"Aren't you clever!" George exclaimed, and the others chimed in with their congratulations. Rosa and Pepper beamed.

The *federales* brought Westerman and his gang ashore in a motor launch. The Maya villagers arrived at the same time with the divers they had nabbed at the *cenote* and handed them over to the police. They had also managed to capture Pedro when he came back for his buddy. The Maya were angry, they said, tired of people stealing their past.

"Nasty accident you had there," Pepper said to Westerman. "Guess that's what you get when you play with fire."

"That's what he gets when *we* play with fire," Rosa quipped.



Westerman wasn't amused. He glared at all of them. "I don't understand you," he said, his tone arrogant. "Working for peanuts to dig up relics that are worth thousands, just to turn them over to some museum. You're all suckers."

"I'd say you're in a strange position to call *us* suckers," Jean snapped back.

"You guys are going to be spending some time in jail," Victor said, as the police led them away.

"Not as much as Westerman," Pedro shouted furiously. "I can tell you *all* about Mr. Westerman."

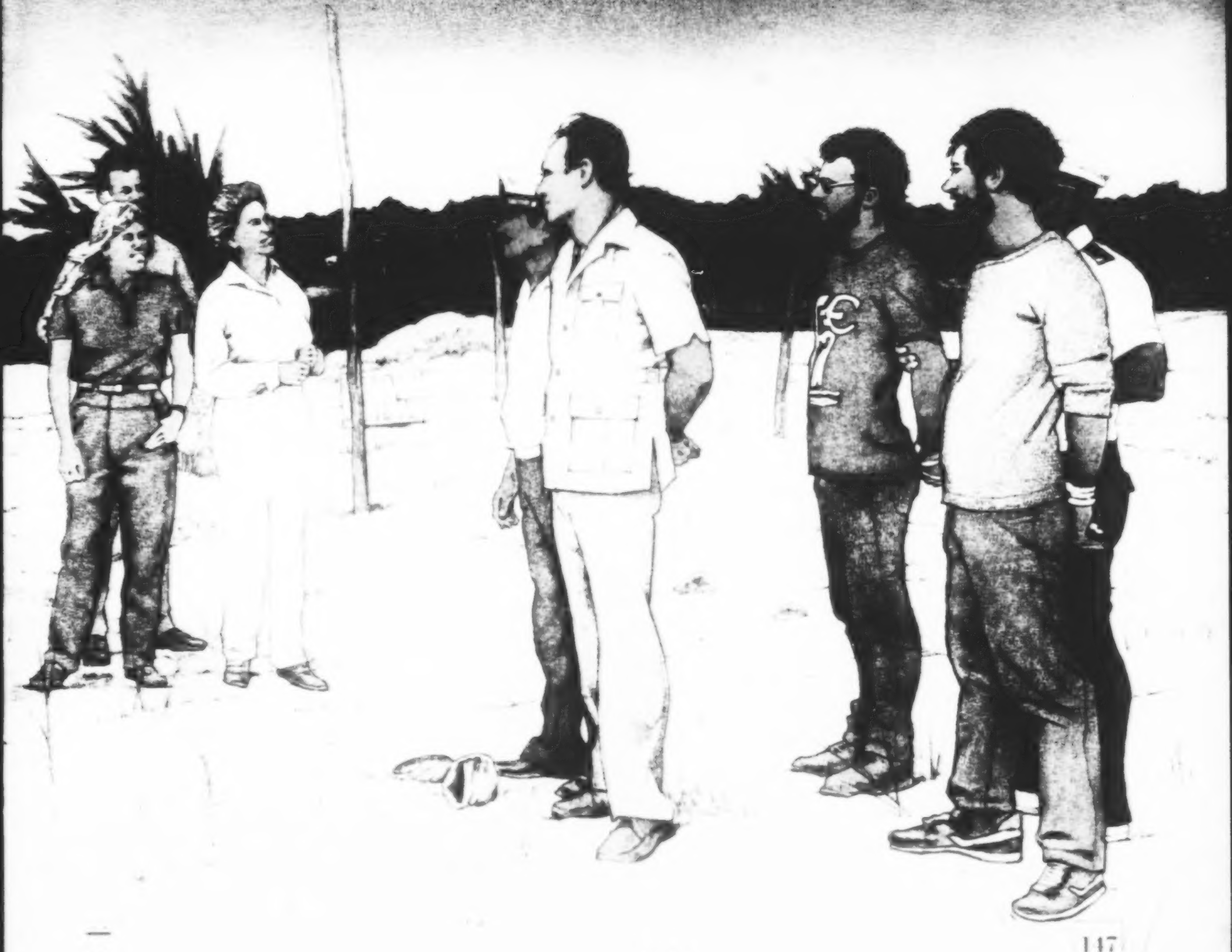
"See you, Harv," Pepper called. "Don't forget to write."

It was a great feeling to see the looters being carted off to jail. Everyone was elated. And hungry. They hadn't eaten for hours, and it was way past dinner time. Fortunately, Segovia had arrived and invited them all to a celebration dinner, and they set off eagerly towards his house.

"Did that little temple mark the winter solstice?" the Captain asked Segovia, referring to the **archaeoastronomer**'s theory about the original purpose of the "lighthouse."

Segovia sighed; he said that the coast had been cloudy during the solstice, so he hadn't been able to test his hypothesis. "I'll be back next year," he vowed. "That little temple has been marking the winter solstice for a thousand years, I'm sure of it."

The Captain hoped Segovia's theory would turn out to be right.



We spent the next few days in Mérida, making our report to the authorities. Then we came back here to take a closer look at the Lost...I mean...Found City.

C.T. was sitting at the base of the pyramid, bringing his journal up to date. He heard Victor calling him. *Terry and Victor say it was definitely a major city!* he concluded, and ran off to find the others.

Victor had found an entrance to the pyramid. They entered quietly and followed a vaulted passageway deep into the interior until they came to a dry wall that closed off the corridor.

"Could it be a tomb?" Quiché asked.

"Maybe," was all Victor would say, but you could hear the excitement in his voice.

It took a while to dismantle the wall, stone by stone. Once they'd made a hole big enough to look through, Victor aimed a flashlight inside. "It *is* a tomb," he said, his voice bouncing off the stone walls.

They squeezed together to get a peek. The flashlight revealed a skeleton lying on the ground, surrounded by ceremonial vases. Leaning against the skull was a beautiful jade death mask. It was an eerie and wonderful sight, and it took their breath away.

"It's Chac Balam!" Quiché gasped. She had spotted a series of glyphs on one of the walls of the chamber. Among them was Chac Balam's name glyph. Chac Balam! The fellow on their stela and pot, the lost king of Cobá. [illegible] he lay.

There was a hush as Quiché studied the other glyphs. "There's a calendar date," she said, pointing. She paused again, struggling to interpret what she was seeing. "On the day, 11 *cauac*, 2 *mac*, was captured Chac Balam of Cobá," she read, very slowly. "Count forward 1 *uinal* and 2 *tun* to his...what do you call that word when somebody becomes king?"

"Accession," Terry answered, her eyes dancing. "His accession as Lord of...Site U!!" she exclaimed triumphantly, recognizing the last glyph. "A lost king for a lost city!"

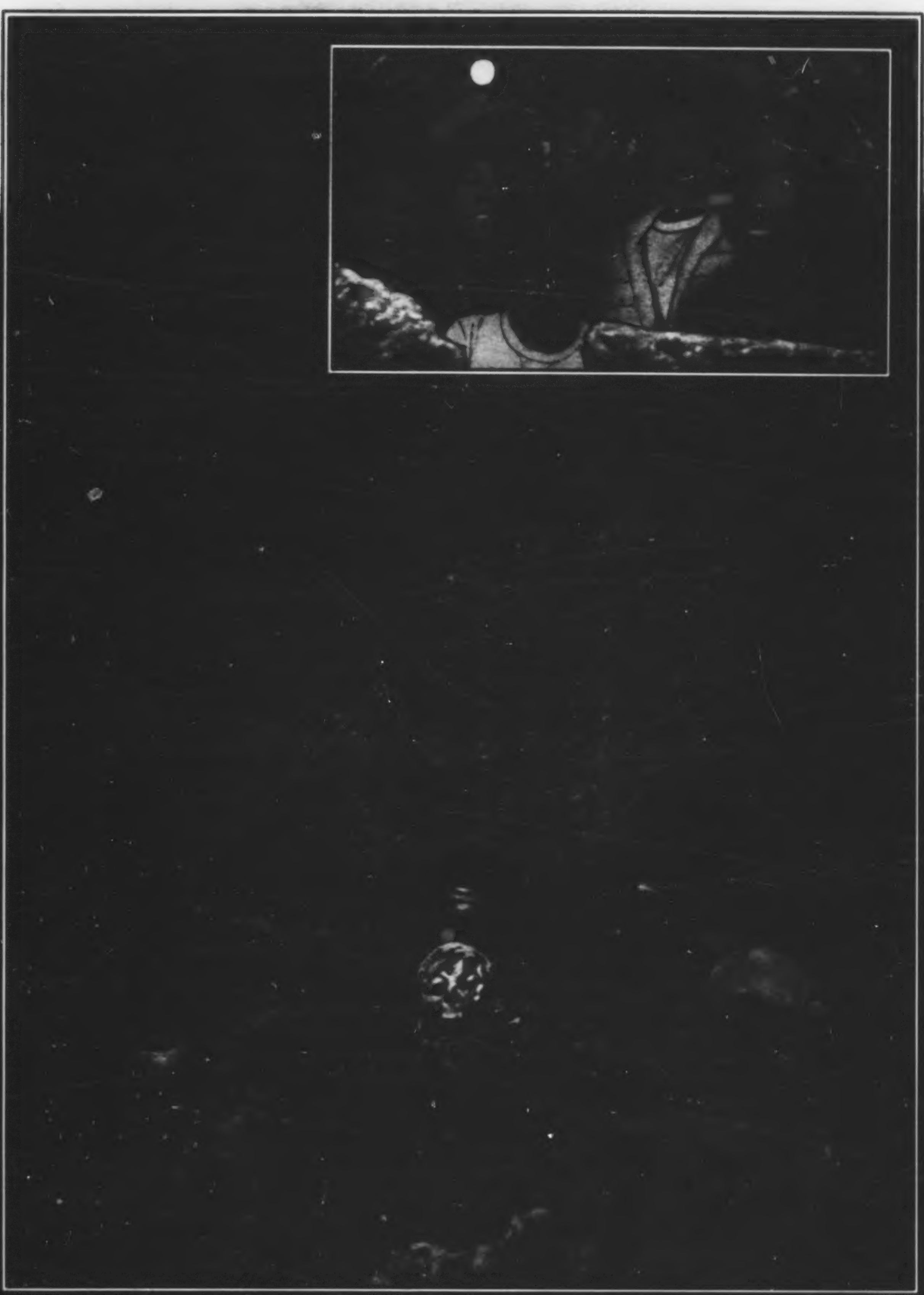
C.T. didn't get it. Wasn't Chac Balam the captured king of Cobá? Wouldn't he have been sacrificed by the people of Site U? Terry said yes, that would be the normal course of events, but in this case it looked like he ended up becoming the king instead. Possibly the old king died without an heir, and they decided to crown their prisoner because of his royal blood.

It was all guesswork for now, Victor stressed, but it certainly seemed like a plausible theory.

Terry added, "And some folks will spend their years fighting the mosquitoes, just like us. And maybe in ten years—with a lot of luck—they'll turn up an answer or two."

"I wouldn't mind doing that," C.T. said in a hushed voice.

"Neither would I, C.T.," Terry said.



They were overjoyed by their discovery. And amazed that Westerman hadn't found it first. Later in the afternoon, they sat on the steps of the pyramid. The jungle extended in all directions as far as the eye could see. They were still discussing their good luck when a visitor appeared. It was Avram, C.T.'s friend from the village. He greeted them shyly, then handed C.T. a package.

It was a pot, a perfect replica of the pot that led them to Site U in the first place. They figured C.T. deserved it, since he hadn't been allowed to keep the first pot or the jade head Avram had given him.

It was Quiché's idea, but Terry had made it for him. It looked just like the original, except that it didn't have a hole in it. And it had something extra: the *Mimi II* glyph.

"It's your going-away present," Quiché announced.

Going away! C.T. realized he'd lost track of the days, and he'd be leaving soon. It wasn't going to be easy to say goodbye to all the great friends he'd made in the Yucatán.

Now we're back in Tulúm, C.T. wrote in his journal. They were all back on *Mimi* again, in the calm waters inside the reef off Tulúm. He munched on a tortilla from his new souvenir pot. *Terry and Victor will be picking up where they left off when we found the stela. Tomorrow, I go home. Mañana, voy a casa. I sure am going to miss everybody.*

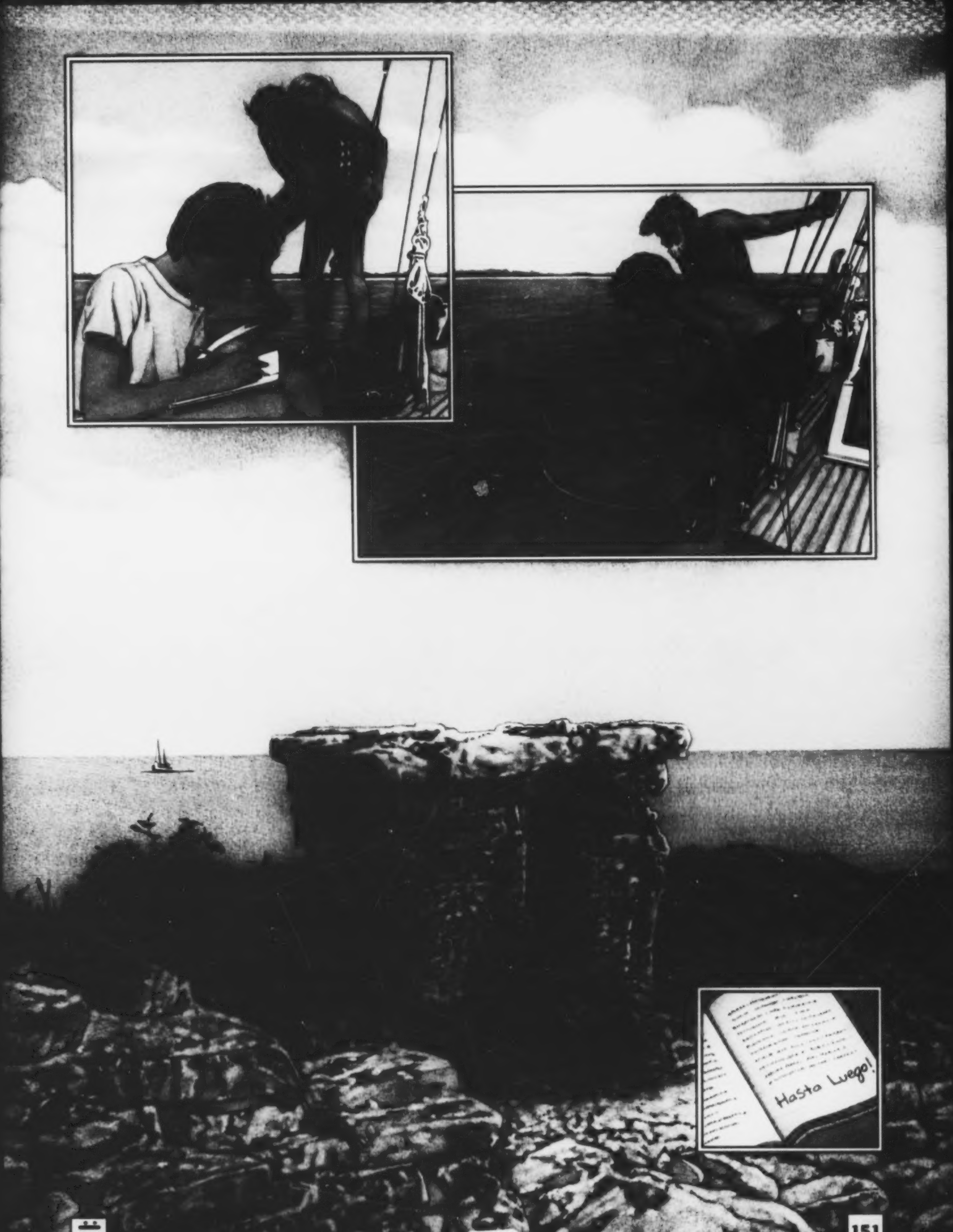
"Last one in swabs the decks!" his grandfather shouted. Terry and Victor were already in the water. Pepper and Quiché were about to dive off the side.

"Wait a minute!" C.T. shouted. He rushed to finish the line he was writing. *Hasta luego*, he wrote in bold letters.

His grandfather had his shirt off, and all the others were in already. C.T. threw down his journal and tore off his T-shirt. He hated swabbing the decks.

He hit the water a second after his grandfather. "I guess you swab the deck one more time," Granny laughed.

"Hey, no way. It was a tie!" But his shouts were doused by a splash in the face. They fooled around in the clear emerald water near *Mimi* for a long time, swimming and laughing and splashing. C.T. didn't want to get out; he was going home to a foot of snow.


Hasta Luego!

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ACTIVITY

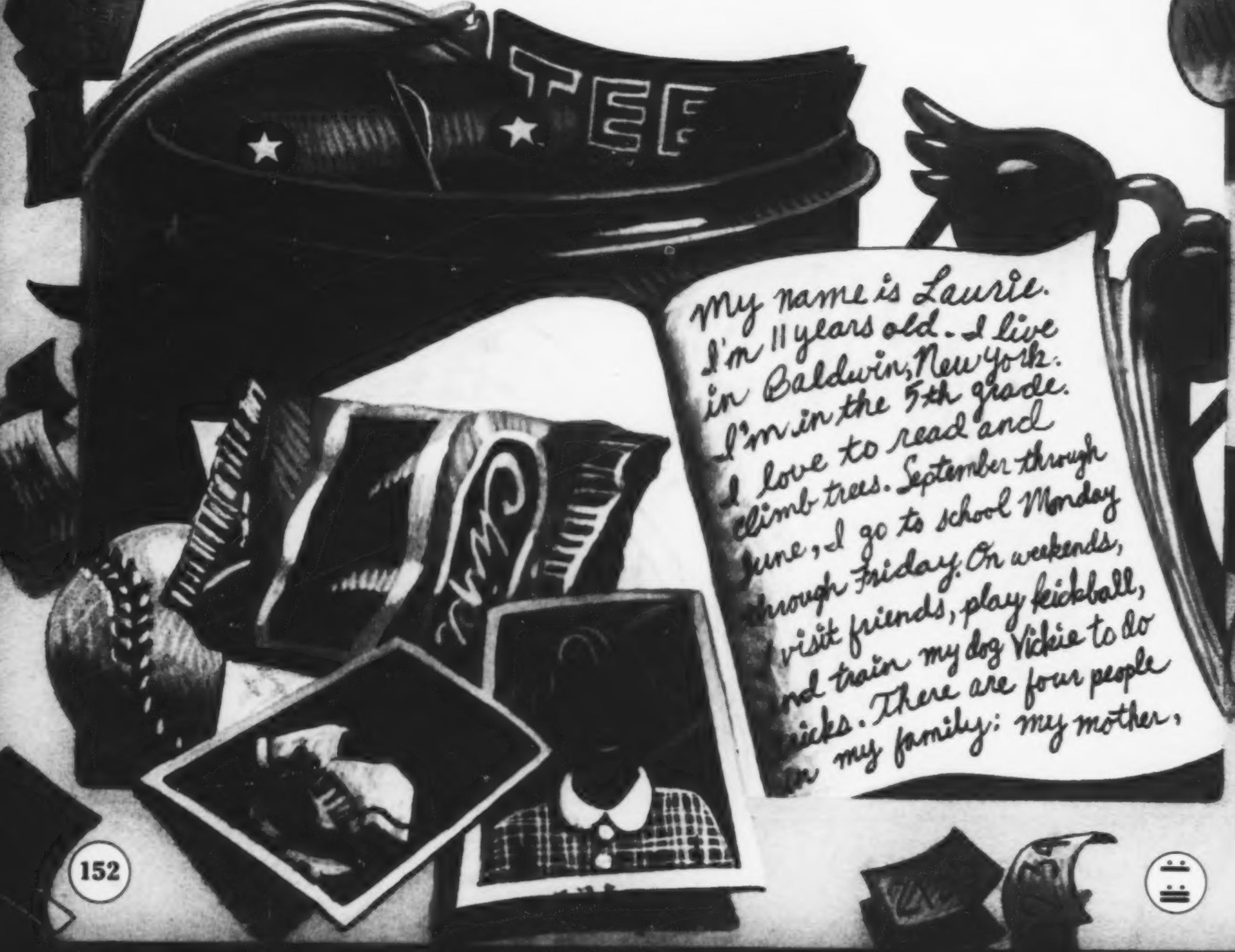
Time Travel

Artifacts can be thought of as time machines. They don't really take you back in time. But by studying them and imagining how people made them and used them, you can imagine what life might have been like in another time. It's tricky because people don't deliberately leave artifacts around. Archaeologists usually study odds and ends—things that happened to have been preserved.

You could help future archaeologists. Make a time capsule filled with artifacts that tell the story of your everyday life. Include as many details as possible. For objects too big or valuable to bury, use photographs.

Bury the artifacts in a waterproof, air-tight container, because in those conditions, they will not decompose for thousands of years. A container made of glass or plastic will work.* Make a map showing exactly where you buried your time capsule. You, yourself, may want to excavate it a few years from now. It will tell you about your own past life. Or, you may want to leave it for future people to find.

*Compare these instructions to Activity 5, where you buried artifacts so they were exposed to the soil, soil creatures and water. Why are these instructions different?



My name is Laurie.
I'm 11 years old. I live
in Baldwin, New York.
I'm in the 5th grade.
I love to read and
climb trees. September through
une, I go to school Monday
hrough Friday. On weekends,
visit friends, play kickball,
nd train my dog Vickie to do
ricks. There are four people
n my family: my mother,

EXPEDITION

[illegible]

A modern-day limestone temple.

Nobody really knows just what all the ancient Maya buildings were used for. They do know that some of them were temples, probably for religious ceremonies. Ben Affleck visited a modern-day temple, the Cathedral of St. John the Divine, in New York City.

A **Gothic** cathedral may not look much like a Maya temple, but in one way they are similar. Like all Maya temples, St. John is built of thousands of limestone blocks.

Limestone was formed at the bottom of great seas. Over thousands of centuries, the shells and skeletons of millions of sea creatures piled up on the bottom. As the pile got bigger and heavier, the shells crushed and compacted into solid rock. Sometimes you can still find the fossils of these tiny creatures in the stone.

The limestone for the Cathedral comes from Indiana. Huge chunks of it are cut from **quarry** walls and trucked all the way to New York. No one knows how the Maya did this. They didn't even use animals to help with their work. Even now, with all kinds of machinery, it takes a long time to complete a cathedral. This one's been under construction for nearly a hundred years.

When it's finished it will be the largest Gothic cathedral in the world. That may take another hundred years. A lot of the work is still done by hand, the way cathedrals have been built for the last eight centuries. Right now they're working on one of the two big towers on the front of the building.

Each limestone block has to be individually cut and carved, then it's hoisted into place. The shop where the stone is cut is right next to the Cathedral. Alan Bird, a master stonemason from England, is in charge of the cutting.

"I think the best way for me to explain what happens here in the stoneyard is to follow the life of one stone—right from the quarry until we actually set it on the tower," said Alan.

For each block there's a card with a picture and the dimensions of the block—kind of a recipe or blueprint. The block they decided to follow is called a **gablet** block. On a blueprint, Alan showed Ben exactly where that particular stone would fit into the tower.

Ben and Alan went to the cutting shed. There, a huge diamond-tooth gangsaw was slowly cutting through a mass of raw limestone. Diamonds are used in the teeth of the saw because they are much harder than steel, they cut accurately and are fairly durable. The gangsaw cuts at the rate of six inches per hour—not very fast, but it beats cutting by hand. A steady stream of water fell on the blade and the stone. The cooling water keeps the

Ben operated the smaller saw to cut the block to manageable size.

blade from overheating from all the **friction**. It also helps keep the dust down.

Once a block small enough to manage had been cut, Alan drew the actual shape of the block on each of its sides, using life-size patterns or **templates** made of zinc. Then a smaller saw cut out large chunks of the stone that were not needed.

The next stop was the cutting banker or bench where the handwork began. First, big chunks of stone were chipped away with a large chisel. "This is called pitching," said Alan. He let Ben use an electric chisel to knock off some unwanted stone.

The block still looked pretty rough and raggedy. Carol Hazen, one of Alan's **apprentices**, used hand tools to smooth the stone into the exact shape required.

Alan started learning to cut stone when he was just sixteen. He wasn't doing well in school until he was sent to college as part of his apprenticeship. "When I was young and in school, I couldn't see much purpose to what I was being taught. But doing well at a craft like stonecutting showed me there was a reason for it all. Working with a piece of stone made me realize that things like geometry and mathematics really made a lot of sense. I found I could get a lot of satisfaction out of it and a lot of love for what I do," Alan said.

Once the cutting was finished, the block was ready to have a design carved on it. To move it to the carving shed, they had to put a hole in it first. Then a gadget called a lewis pin was inserted into the hole. The lewis pin is made of two bent pieces of metal hung together. When the pin is lifted from the top, it tries to spread apart at the bottom and presses against the side of the hole. With the lewis pin in place, a crane lifted the block and carried it to the carving shed.

No power tools are used for the delicate work in the carving shed. The carver assigned to finish this block was Cynie Linton. Cynie used a clay model as a guide for her carving.

Ben used an electric chisel in a process called "pitching." Cynie Linton was assigned to do the final carving work on the block.

She spread out an array of tools: an old wooden mallet, a rubber mallet and a variety of chisels of different sizes.

Before she learned to carve, Cynie spent four years in the cutting shop. She was Alan's first apprentice. "Sometimes I miss being over there," she said, "because this is a lot of little work, little tapping. Over there, you can really pound away at what you're doing. There, you have templates and you know exactly what you're supposed to come out with. You can measure it and check it all along the way."

"Do you ever make really big mistakes?" asked Ben. It looked like one false stroke of the hammer could destroy the work of days.

"Not too often," Cynie replied. Ben watched, fascinated. Cynie kept tapping away as she talked. Slowly, a pattern of graceful curves emerged from the square stone. At the end of two days, the stone was smooth and a delicate "leaf" pattern had been carved in it.

When a block is finished, it's marked off on a large drawing of the Cathedral tower. Each person's work is represented by a different color. Cynie's color is purple.

The block was getting to be an old friend, so Alan suggested Ben carve something on it where it wouldn't show. He showed Ben how to use a hammer and chisel to carve "Mimi" on the back of the block.

Next the block was taken by outdoor elevator to the top of the Cathedral. They went up about a hundred and sixty feet! Ben couldn't imagine how this was done a hundred years ago or how the Maya did it fifteen hundred years ago. Pulleys and an overhead track, along with another lewis pin, made it pretty easy to move the block into place on the tower.

A kind of cement called mortar was spread on the block the new gablet stone would rest on. It didn't take much since the block weighs about 550 pounds and isn't likely to blow away.

"How long will it take to finish the whole cathedral?" Ben asked.

"I don't think you or I will be alive to see that day. Cathedrals, in general, take centuries. I always tell my guys it's one stone at a time. If you complete one stone, then you've achieved something," Alan replied.

Three hundred million years ago, this block was just a bunch of sea creatures. Six months ago, it was part of a wall of limestone in an Indiana quarry. Now, after thirty hours of cutting and shaping, it went into place high on the south tower of the Cathedral of St. John the Divine. Maybe fifteen hundred years from now archaeologists will wonder about this temple and the block with the strange inscription in ancient English, "Mimi."

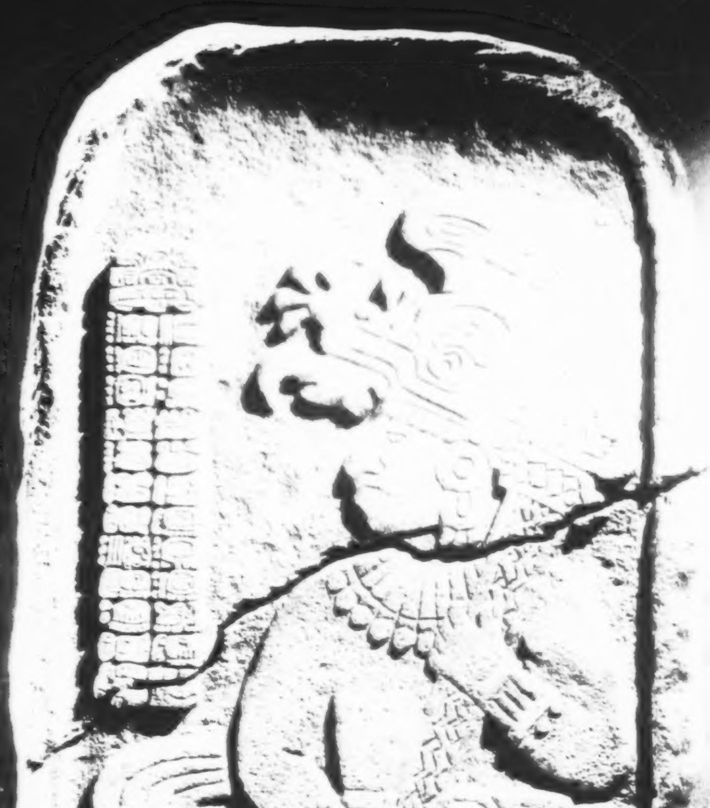
Will future archaeologists wonder about this limestone temple and the block with "Mimi" etched on the back?

BE A ROCK-A-PHILE

Check out the stone buildings in your town. Take a magnifying glass and look closely.

If the building is made of limestone, look for fossils. If it is made of sandstone, look for individual grains of sand, cemented together by nature. Granite has wonderful patterns created by its minerals. Are there carvings in the stone? Is the stone eroding?

Find out whether the stone is local or came from far away. Have you seen outcroppings of the same kind of stone? Is there a quarry in your town?



MAYA STELA

(Theatrical Prop from "The Second Voyage of the *Mimi*")

Approximate dimensions: 5'4" high, 2'8" wide, 7" thick

Material: fiberglass and resin

In "The Second Voyage of the *Mimi*," the *Mimi* crew finds part of an ancient Maya monument (called a stela) on the bottom of the lagoon at Tulum. Hieroglyphic writing on the fragment concerns a great (fictitious) Maya ruler named Chac Balam ("Strong Jaguar" or "Red Jaguar"), Lord of Coba. When the other half of the stela is found and the two pieces are fitted together, the carved inscriptions on the monument can be read, and the story of Chac Balam ends in a tantalizing mystery. After only four years as King of Coba, Chac Balam was captured by "Bird Skull," ruler of Site "Q" — a major Maya site long known to exist because of monumental references like this one but never found by archaeologists.

To design the picture to be carved in relief on the stela and the accompanying hieroglyphic text, the "Mimi" producers turned to George Stuart, chief archaeologist for the National Geographic Society and a world-renowned Maya scholar. George, in turn, recruited his son David, youngest winner of the MacArthur Award and expert in Maya hieroglyphs.

The stela was fabricated out of fiberglass and resin by Sr. Juan Martinez Montemayor, a Mexican sculptor experienced in making prop artifacts for films and television programs. He first modeled the two pieces of the monument in clay, then made latex molds to form the final product. Gray pigment added to the final coat of resin gives the appearance of weathered stone. Concealed openings in each hollow piece allow sand to be added to provide credible weight.

GLYPH TRANSLATION

[illegible] patron god of the month "Ceh."]

[On the day in the Long Count Calendar]

9 Baktun — A2

15 Katun — B2

6 Tun — A3

3 Uinal — B3

1 Kin — A4

[corresponding to the date]

2 Imix — B4

With Lord 8 of the Night in power — A5–B5

4 Ceh — A6

Acceded to the office of — B6

Lord of the Succession — A7

Chac Balam — B7

[Lord of] Cobá — A8

Count forward — B8

18 Kin and 1 Uinal — A9

4 Tun — B9

To reach the day — A10

11 Cauac — B10

2 Mac — A11

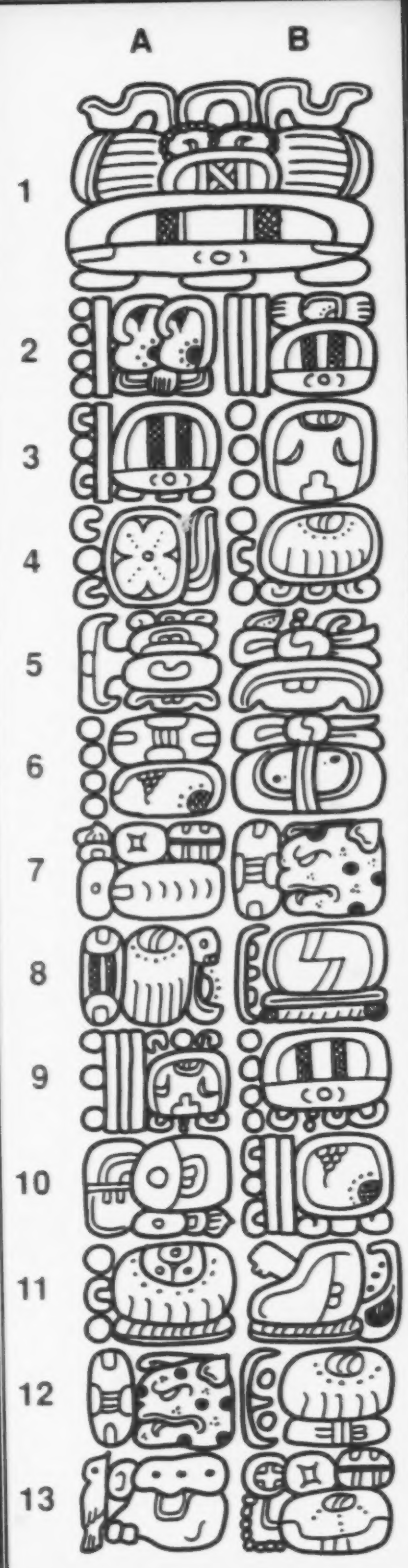
Was captured — B11

Chac Balam — A12

The captive of — B12

Bird Skull — A13

[Lord of] Site "U" — B13



A

abdomen: the hind part of an insect's body

absorb: to suck up or drink in (a liquid)

accession: the act of attaining power or a throne

amputate: to cut off, usually by surgery

anaesthesia: partial or total loss of the sense of pain

antivenin: a serum that counteracts the poisonous effects of venom

apparatus: instruments or tools used for a specific purpose, like an experiment

apprentice: a person who works for another in order to learn a trade

arachnid: type of arthropod with four pairs of legs and breathing tubes, including spiders, mites, ticks, and scorpions

archaeoastronomer: one who studies the astronomical knowledge of ancient civilizations

archaeobotanist: one who studies ancient plants

archaeologist: one who studies the life and culture of ancient people by studying their monuments, artifacts and inscriptions

artifact: any object made by human work

ascender: a thing that goes up or helps one to go up

astronomer: one who studies stars, planets and other heavenly bodies

atmospheric pressure: the pressure on the earth due to the weight of the earth's atmosphere, an envelope of gases that extends to a height of about 22,000 miles; at sea level, atmospheric pressure is equal to about 14.69 pounds per square inch

authentic: genuine, real

B

ballast: anything heavy carried in a ship or aircraft to give it stability or to control the depth or altitude

barometer: a device for measuring pressure

bearing: a direction, relative to a particular position

bends: pain or paralysis caused by the formation of nitrogen bubbles in the blood because of a sudden lowering of atmospheric pressure (also called caisson disease and decompression sickness)

biologist: a scientist who studies plants and animals

botanist: a person skilled in botany (plant science)

bowline knot: a knot used to tie off a loop so it won't slip

C

calibrate: to establish or correct the measurement markings on a measuring instrument, like a thermometer

camouflage: device or technique to disguise or hide something from an enemy

carabiner: a strong metal ring with a hinged gate that automatically closes itself; used in mountain climbing

carbonated: filled with carbon dioxide

Cartesian coordinates: a pair of numbers that locate a point by its distance from two intersecting lines

cenote (Spanish, from the Mayan *tzonot*): a deep natural well carved out of limestone; sinkhole

centrifuge: a machine that separates particles of different densities by means of centrifugal force–a force that tends to pull a thing outward when it is rotating rapidly around a center

compress: to press together, to force into less space

condense: to change to a denser form, as from a gas to a liquid

conquistador (Spanish): one of the Spanish conquerors of the Americas during the 16th century

coral head: a large piece of coral

coral polyp: a small marine animal with a soft, tube-shaped body and a mouth surrounded by tentacles; some make hard skeletons that form coral reefs

core temperature: the temperature deep inside the body of a mammal

cortisone: a hormone often used to treat certain allergies and arthritis

curandero/curandera (Spanish): healer

curio: any unusual article (from curiosity)

D

daub: a soft, sticky mud or plaster used to cover or coat something (also used as a verb)

decipher: to figure out the meaning of; to translate

decompose: to break down or separate into basic parts

decompression: gradual return to normal atmospheric pressure after being in deep water or compressed air

detritus: build-up of disintegrated material

diagnose: to identify an illness by medical examination

dung: animal excrement; manure

dynasty: a series of rulers from the same family

E

ecology: the study of relationships among living things and their environment

electrode: a terminal that conducts an electric current into or away from a substance

emblem glyph: a hieroglyph that identifies a particular ancient Maya city

epiphyte: a plant that grows on another plant but is not a parasite

equator: an imaginary circle around the earth that is equal in distance from the North and South Poles

esophagus: a tube connecting the mouth with the stomach

Eustachian tube: a slender tube between the middle ear and the back of the throat that helps equalize air pressure on both sides of the eardrum

evaporate: to change from a liquid or solid into vapor (gas)

evolve: to develop gradually by a process of growth and change

expand: to grow bigger; to spread out

extinct: no longer in existence; having died out

F

fluent: able to write or speak easily and smoothly

fossil: hardened remains of animal or plant life from a past geological age

friction: rubbing of one object against another

G

gablet: triangular stone used in building, usually above an entrance or window

galvanize: to coat metal, usually iron or steel, with zinc

Gila monster: a slow-moving venomous lizard with a short tail and covered with orange and black scales; found in desert regions of Mexico and the United States

glyph: a symbolic character, usually carved

graduated cylinder: a long thin container used by scientists to measure liquids

Gothic: related to a style of architecture developed in Europe in the 12th through 16th centuries; characterized by flying buttresses, pointed arches, steep roofs

gram: basic unit of weight in the metric system; equal to about 1/28 of an ounce

guacamole: sauce or dip made from avocados

guinea pig: a small, fat mammal of the rat family, often used in biological experiments; a person or thing used in an experiment or test

H

hieroglyphics: system of writing in which a picture or symbol represents a word, syllable or sound

humidity: dampness; moisture in the air

hypothermia: the condition of a body when it loses so much heat that the core temperature drops dangerously low

hypothesis: a theory or proposition which has not yet been proven

I

implode: to burst inward

insulate: to cover, surround or separate with material that will prevent or reduce the transfer of heat, electricity, or sound

Iron Age: the period in history when people began to use iron to make tools and weapons; occurred in Europe around 700 B.C. to 50 A.D.

K

kiln: a furnace or oven for baking or drying things like bricks and pottery

L

lead: a wire carrying current to or from a piece of apparatus

lichen: small plant made up of a fungus living symbiotically with an alga; often grows on rocks or other plants

loot: to steal artifacts from an archaeological site

M

machete: large knife with a heavy blade used to clear underbrush and to cut sugar cane

manatee: large plant-eating mammal that has flippers and a wide, flat tail; found in shallow tropical waters

Maya: group of people native to the Yucatán Peninsula and parts of Central America whose highly developed culture flourished between 300 and 900 A.D., and then collapsed

meridian: any of the lines of longitude running north and south on a globe or map, passing through the north and south poles

metabolize: to carry on the physical and chemical processes by which the bodies of living creatures are built up and kept going

midden: a garbage heap

molecule: the smallest bit of an element or compound that has the qualities of the element or compound

mortar: a hard bowl in which softer substances are ground, usually with a pestle; a mixture of cement or lime with sand and water, used between bricks or stones in building

mucous membrane: a mucous-making tissue lining inside parts of the body that come into contact with air, keeping them moist

N

nitrogen narcosis: loss of the ability to think clearly, caused by the inhalation of too much nitrogen, as by deep sea divers; also called **rapture of the deep**

nutrient: anything having value as food

O

obsidian: hard, usually dark-colored glass formed by volcanos; can be worked to form extremely sharp edges

P

percolate: to pass a liquid through small spaces or a porous substance

parasite: a plant or animal that lives in or on the body of another plant or animal, getting nourishment from it, and usually harming it

pestle: a tool used to pound or grind a substance; usually used with a mortar

petri dish: a very shallow, clear dish with a loose-fitting cover, used to grow micro-organisms

phantom pain: pain sometimes experienced by amputees in parts of their body that have been amputated; the result of nerve endings that remain in the brain, even if part of the body has been amputated

polar coordinates: mathematical system for locating a point on a plane, using distance and bearing from a central, fixed point on a fixed line

poultice: a soft moist mixture put on the body as medicine

prosthesis: an artificial replacement for part of the body

pupae (plural of pupa): insects in the stage between larva and adult; usually enclosed in a cocoon

Q

quarry: a place where stone for building is excavated by cutting or blasting

R

radiation: the process in which energy (like heat, light, or x-rays) is given off, moves through space or another substance, and is absorbed by another body; radiation therapy is a cancer treatment which involves bombarding the cancerous part of the body with certain kinds of radiation to kill the cancer cells

radioactive: giving off energy in the form of rays or particles as a result of the breakup of atoms

rapture of the deep (see **nitrogen narcosis**): so-called because of the intoxicated feeling that accompanies it

rappel: to descend (a cliff face or a tree) using a rope tied above and wrapped around the climber's body to control the rate of descent

reef: a ridge of coral or sand near the surface of the water

regulator: a device on a scuba tank that adjusts the pressure of the air the diver gets from a tank to match the pressure of the water he or she is in

relic: an object or custom that has survived from the past

replica: a copy of a work of art or other object

rite: a formal, ceremonial act, usually part of a religion

rotate: to turn around a center point or axis

S

sac: a structure in a plant or animal that's shaped like a bag or sack

sacbe (Mayan): an ancient Maya footpath or road

salvage: to rescue a ship or cargo at sea

sarcophagus: a stone coffin or tomb, often decorated with carvings

sauna: a bath in hot, dry air

scuba: equipment used by divers for breathing underwater; usually includes one or two compressed air tanks and a hose connecting them to a mouthpiece

sensor: a device to detect and measure temperature or light and transmit the information to a recording machine

sherds: pieces of broken pottery (same as shards)

shunt: to change the path of blood in the body

snorkeling: swimming just under the surface of the water with a breathing tube, called a snorkel, that extends above the surface of the water

solstice: the two times of the year when the sun is furthest from the celestial equator; summer solstice occurs around June 21 and winter solstice occurs around December 22

solution: a uniform mixture formed by combining a gas, liquid, or solid with another gas, liquid, or solid

sonar: a method for finding objects underwater by means of the sound waves they reflect

species: a biological grouping for members of a group of plants or animals which are very similar, and can usually only interbreed among themselves

specimen: one individual of a class or group, used as an example of the whole group; a typical individual

sphere: a solid round figure with all points on the surface equally distant from the center; a ball or globe

stela: an upright stone slab, carved with inscriptions

stonemason: a person who cuts stone to shape and uses it in making walls, buildings, etc.

subsistence: surviving with the barest of necessities

succulent: having thick, fleshy tissues for storing water

sundial: a device that indicates time by the position of the shadow cast by a vertical object at its center

symbiotic: a relationship in which two kinds of organisms live together, each helping the other in some way

symmetry: similarity in form and arrangement of things on opposite sides of a center line

synchronize: to set to the same time; to cause to happen at the same time or the same rate

T

telson: the stinging segment at the end of the body of a scorpion

template: a thin piece of metal, wood, or paper used as a pattern for making a copy of an object or shape

tentacle: a long, slender, flexible growth, used for grasping, feeling, or moving, usually around the head or mouth of an invertebrate animal

thermoluminescence: the release of stored energy in the form of light from a substance that has been heated

thorax: the middle segment of an insect's body

toxin: a poison created by an animal or plant

transit: an instrument used to measure angles on land, to determine boundaries and make maps

trawler: a boat for fishing by dragging a heavy net along the sea bottom

tropical forest: forest growing in the warm, rainy parts of the area between the Tropic of Cancer and the Tropic of Capricorn, which includes the equator; characterized by tremendous variety of plant life

tuber: a thick, fleshy part of an underground stem of a plant, like a potato

tumor: an abnormal or diseased swelling in the body, usually caused by overgrowth of new, useless cells

V

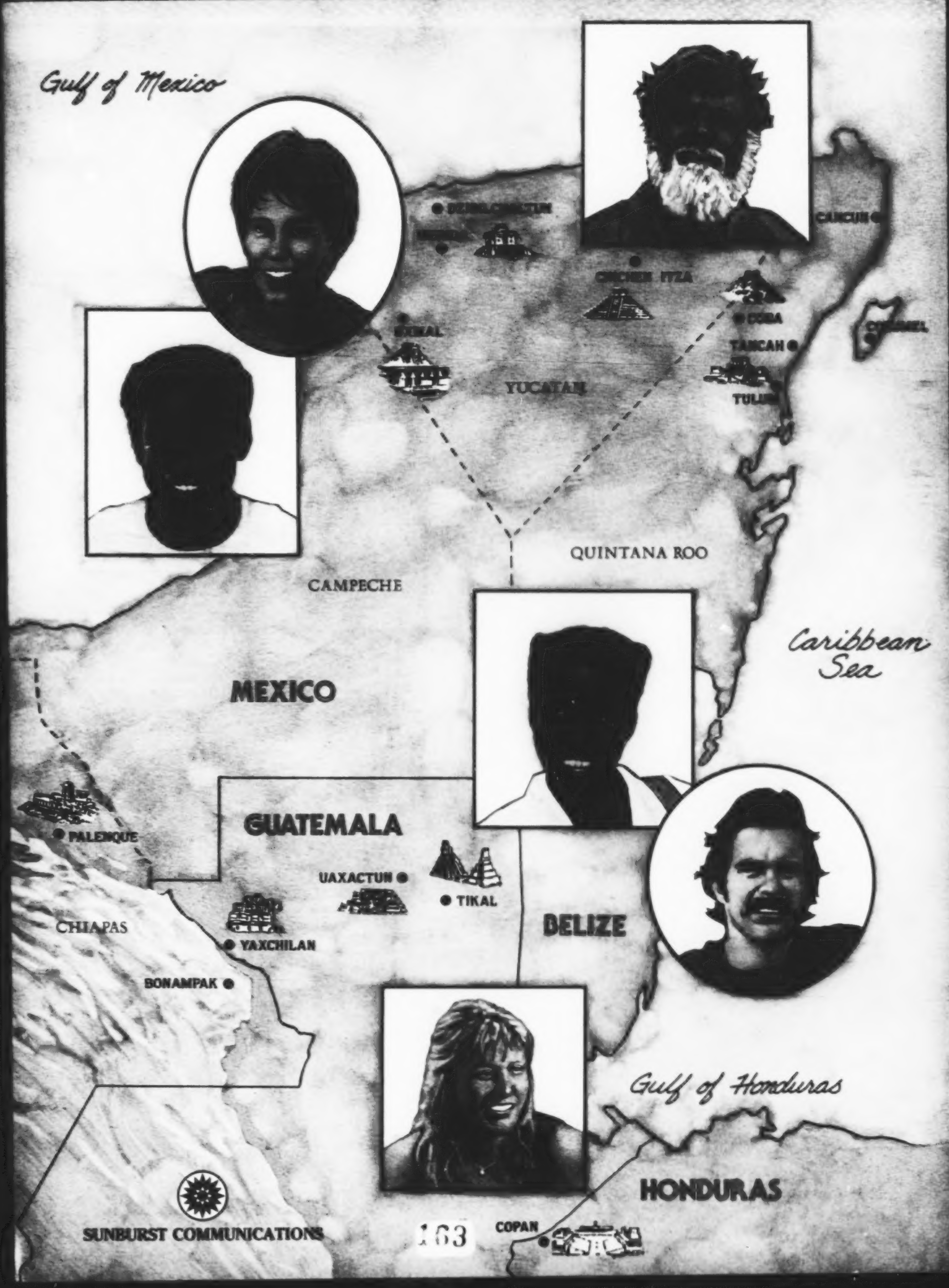
vaccine: a preparation of weak or dead germs put into the body so the body develops immunity to a disease

vapor: the gaseous form of a substance that is usually found as a solid or liquid

venom: a poisonous liquid secreted by some animals, usually injected into victims by bite or sting

vermiculite: a fine-textured, scaly mineral that is often used in potting soil

volume: the amount of space that an object or substance occupies, measured in cubic units


Gulf of Mexico
DZIBILCHALTUN
UXMAL
CHICHEN ITZA
CANCUN
COBA
COZUMEL
TANCAH
TULUM
YUCATAN
QUINTANA ROO
CAMPECHE
Caribbean Sea
MEXICO
GUATEMALA
PALENQUE
UAXACTUN
TIKAL
CHIAPAS
YAXCHILAN
BELIZE
BONAMPAK
Gulf of Honduras
HONDURAS
SUNBURST COMMUNICATIONS
COPAN